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THE Petroleum Engineer

JUN 18 1952
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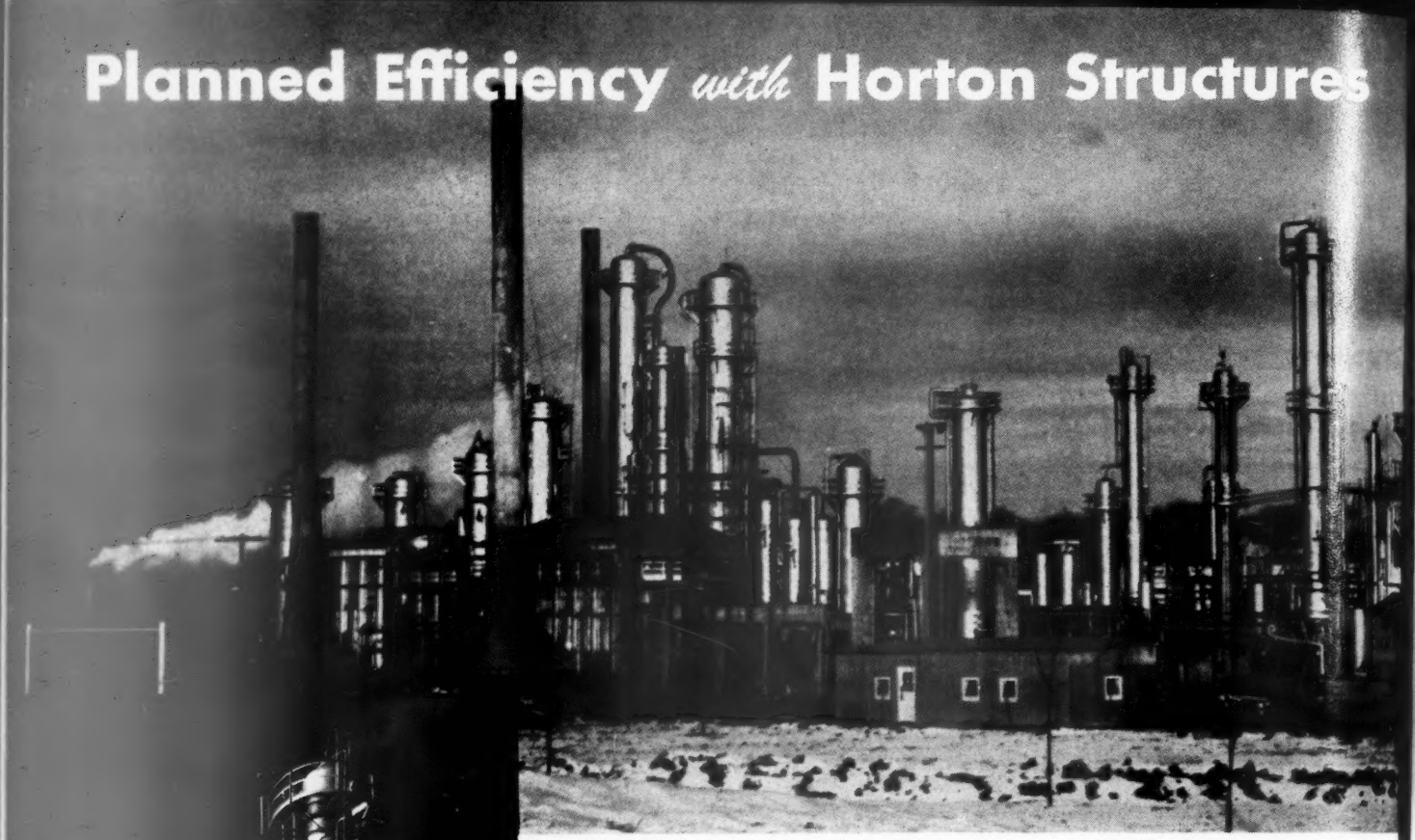
JUNE 1952

Planned Efficiency *with* Horton Structures



Ever since the Rock Island Refining Corp's 10,000-bbl. refinery at Zionsville, Indiana was put "on stream," management has recognized that planned efficiency means greater profits. As a result, all equipment needed in the refinery's operation has been purchased with the expectation of obtaining maximum production and keeping unit operating costs low.

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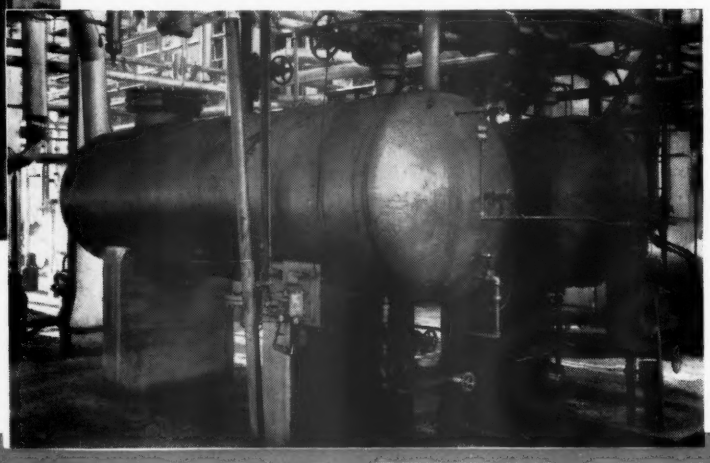
Above: A 3-ft. 6-in. by 39-ft. absorber tower (extreme left) and a 5-ft. by 9-ft. 8-in. cat gasoline debutanizer built for Rock Island Refining Corp.



Left: In the foreground, a 4-ft. by 18-ft. debutanizer relief drum and 4-ft. by 16-ft. water settler tank built for Rock Island Refining Corporation.

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Excessive Taxation Breeds Financial Problems

AN ANALYSIS of some fifty annual reports of oil companies in this issue reveals acute financial problems—problems that stem from excessive taxation. Of this group of companies the average direct taxes paid to the federal government in 1951 was 70 per cent of the net income. Of seven companies in the group the direct taxes paid to the federal government exceeded the net income, averaging 135 per cent of the net income. This in effect meant that these seven companies had to draw on their cash reserves or seek outside capital to maintain their operations.

As for total taxes from petroleum and its products, it is estimated that "in 1951 federal, state, and local governments collected the staggering sum of four and a half billion dollars in taxes levied against petroleum operations and products". This figure, "which includes hundreds of industries and consumer levies breaks down into a single hypothetical tax of $1.86 on each barrel of crude oil produced" in 1951.

In financial statements today dollars are inflated dollars, but depreciation and depletion deductions for replacement are estimated in dollars of historic value. The purchasing power of today's dollar is much less than it used to be. The cost of replacing obsolete equipment or expanding facilities today is infinitely greater, federal taxes are also excessively higher. Deductions for depletion, based as they are on historic values of the dollar, are inadequate to replace the petroleum and its products being sold today. In 1951 allowances for depreciation and depletion of the fifty odd companies analyzed were about one-half of the capital expenditures for that year. In other words, capital expenditures exceeded depreciation and depletion allowances by nearly double. One company reports that its taxes paid and accrued for the year 1951 were the highest in its history and approximately equal to one-half of its total net investment in capital assets. Another company reports that the total taxes paid and collected approximated three times the net income.

Annual financial and statistical reports of oil companies do not support the commonly held belief that the profits of oil companies are fabulous. Instead, the industry's mounting tax bill is real cause for concern. The ultimate detrimental effect on the economic structure of the petroleum industry and its operations is obvious.

As one company has stated "The need for adequate taxes to provide for national defense must be recognized. On the other hand, it is equally necessary that the capital needs of all business continue to be met. Government expenditures therefore should be kept at a minimum to the end that the tax burden shall be no heavier than is absolutely necessary. Only in this way can business make its maximum contribution to the nation's welfare and effectively meet its responsibilities to its customers, employees, and shareholders."—K.C.S.

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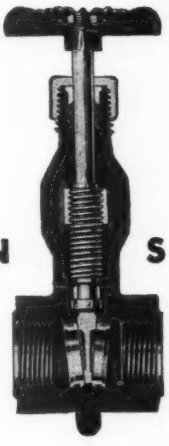

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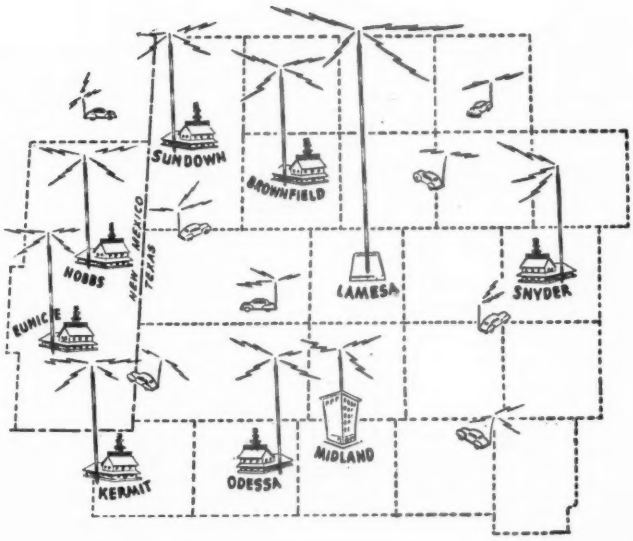

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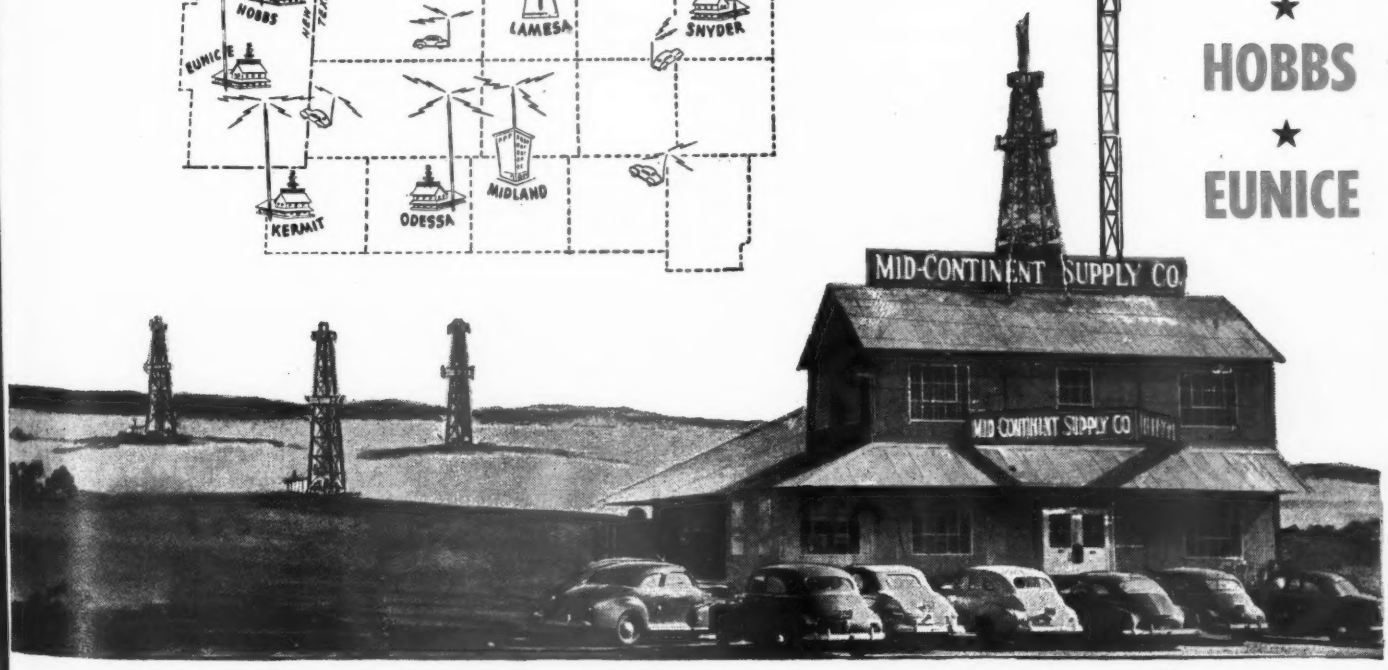

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With the EDITORS.....

Perforated vs Bubble Plates

Information has been received that indicates findings from pilot plant operation showing that perforated plates in certain types of distillation and of liquid-liquid extraction processes have some definite advantages over the more "conventional" bubble plate design. Up to some 20 per cent higher efficiencies have been obtained in large-scale pilot plant operation in some petrochemical processes for the perforated type plate units. In some unannounced petrochemical plants now operating a goodly part of the fractionating and contacting equipment is fitted with perforated plates, and an even larger percentage of the latter type units are going into plants now building or under design.

These plates are relatively thin steel, such as 3/16 in., with holes of the approximately same diameter drilled thickly. Downcomers may be used also, from plate to plate, especially in extraction operations, to handle the continuous phase component. More work is being carried out along these lines, with the researchers' expectations of finding out more about the characteristics of these new designs.—A.L.F.

Calcium Metal From TEL Manufacture

One interesting and potentially important development in the newer method of manufacture of tetraethyllead is that of isolating metallic calcium as a byproduct of the main process. This metal, so very widely dispersed in the earth's crust—second in quantity probably only to silicon—in sedimentary, and other rock, is still one of the rarities, in metallic form, showing even greater resistance to purification than did either aluminum or chromium. Calcium metal in molten state appears as an impurity in the sodium isolated in the electrolytic cells, sodium being a major reagent in TEL production. By means of an involved routine, well proved in pilot plant, the calcium is segregated from the sodium as a finely divided powder, free of nitrogen and containing only small quantities of the oxides of the two metals. Experimental samples are available to possible customers, in 50-150-mesh powder form.
—A.L.F.

6 Per Cent Not Enough

Two different authorities, both addressing the Southern Gas Association annual meeting in Galveston, Texas, recently, agreed that the 6 per cent rate of return on investment plus depreciation allowed by the Federal Power Commission will not be sufficient to finance the $5,000,000,000 future expansion of the natural gas transmission industry projected for the next five years. The speakers were Claude A. Williams, president of Transcontinental Gas Pipe Line Corporation, and August Belmont, vice president of Dillon, Read and Company.

Williams presented mathematical data that computed the "absolute minimum return" necessary under present-day conditions on a typical new pipe line project costing $100,000,000. He then made a similar computation for an established company with a $250,000,000 rate base that is planning an expansion program costing $100,000,000. These were his conclusions:

"It is plain to see that under such circumstances no company would be warranted to expand its facilities if it is to receive only an overall 6 per cent rate of return. In the first place, the dividends would be reduced; in the second place, the common stock could not be sold at an attractive price, and, in the third place, the mortgage requirements could not be met and, therefore, the money could not be borrowed."

Belmont's conclusion was that transmission companies cannot continue to expand their plant at the rate of 20 per cent annually, as during the postwar years, on 6 per cent returns, especially when a substantial part of annual appropriations for depreciation have to be used for retirement of debt. He further explained that the market is lessening for fixed interest and dividend bearing securities because non-regulated industries can pay comparatively higher rates of interest.

What will be the final result?

Sooner or later regulatory authorities will be forced to recognize the inadequacy of 6 per cent as a rate of return sufficient to allow the industry to finance its needs.—F. H. L.

Petrochemicals and Oil Refining

Nothing illustrates the interdependence of large portions of America's chemical and industrial operations better than the effect of the refinery strikes on allied interconnected petrochemical units. During the recent strike several petrochemical plants shut down entirely. Butadiene is made almost entirely from refinery-derived olefins—butylenes. Port Neches butane and other producers of butadiene started shutting down, synthetic rubber companies prepared to do likewise, throwing styrene, the other main constituent of tire-type rubber—GRS—into surplus for the first time in a long period. Monsanto and other hydrocarbon-dependent chemical plants reduced outputs by 30 per cent, some say up to 50 per cent in some plants, before new raw material supplies could be put under way through the pipe lines.

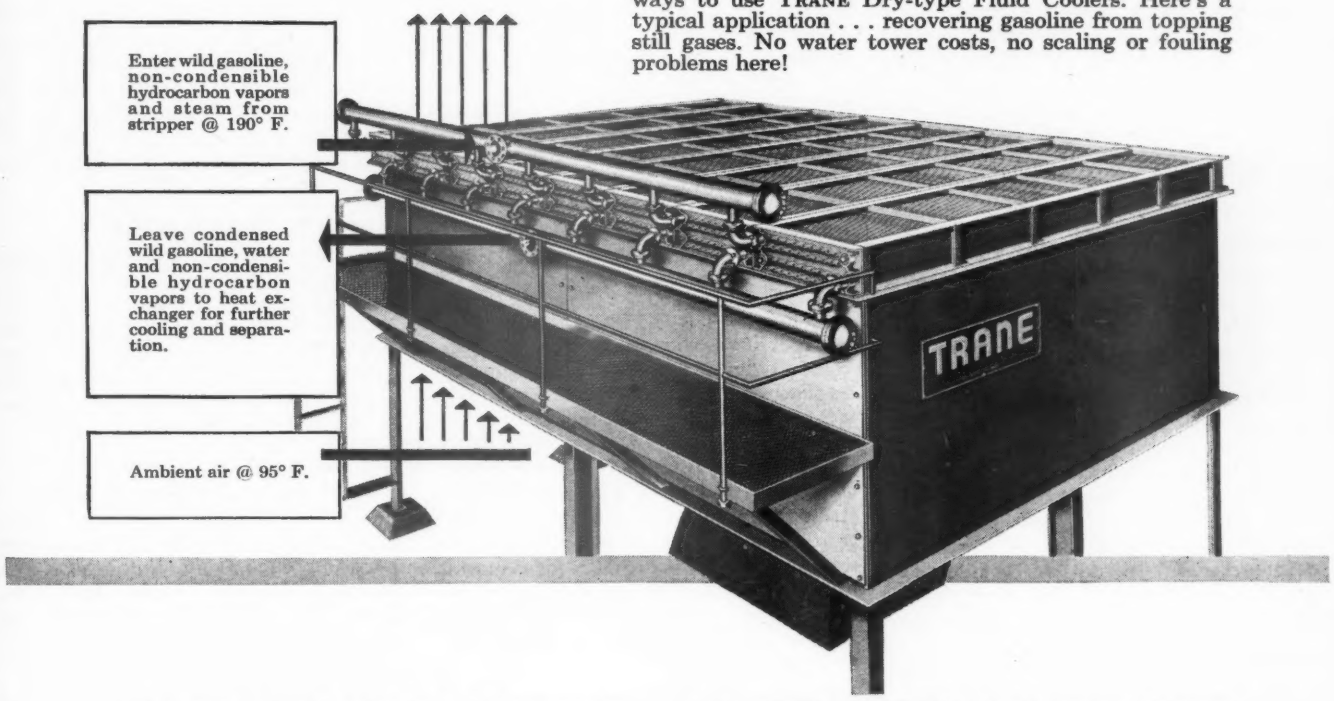
Analogously, supplies of motor fuel were reduced in many parts of the country. About one-fourth of the country's refining capacity was shut down. West Coast refineries stayed on stream, reportedly due to the vital demands for fuels and lubricants for the Korean "police action", supplied largely from the Pacific Coast plants. In fact, at least one petrochemical plant, that of Phillips Chemical, found itself strikebound although its personnel were not engaged in petroleum refining operations at all.

The whole thing is a stentorian, if silent, commentary on what can be done to the productiveness of the country in time of crisis, by a relatively small group who may be in control of the nation's industrial workers. It may be that the definition of "treason" should be revised, with a broadening effect.—A.L.F.

Here's how petroleum processors can cool with air... cut water costs

WITH TRANE DRY-TYPE FLUID COOLERS

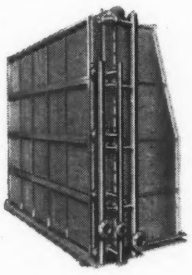
In petroleum processing there are hundreds of profitable ways to use TRANE Dry-type Fluid Coolers. Here's a typical application . . . recovering gasoline from topping still gases. No water tower costs, no scaling or fouling problems here!


Enter wild gasoline, non-condensible hydrocarbon vapors and steam from stripper @ 190° F.
Leave condensed wild gasoline, water and non-condensible hydrocarbon vapors to heat exchanger for further cooling and separation.
Ambient air @ 95° F.
TRANE

In areas where water is in short supply, and where conditions of heavy fouling and scaling are prevalent, petroleum engineers are discovering that TRANE Dry-type Fluid Coolers solve many of their problems.

There are many sizes of TRANE Dry-type Fluid Coolers. Each is engineered to the job. *Consider these advantages . . .*

1. NO WATER PROBLEMS: closed system prevents fouling of water or other fluid.
2. HUNDREDS OF APPLICATIONS: applications are limited only by temperature ranges of air cooling and consistencies of fluids to be cooled.
3. LOW-COST MAINTENANCE: easier cleaning through removable headers. Fewer shutdowns.
4. EASY WINTER MAINTENANCE, compared to cooling towers, because TRANE Fluid Coolers use only air.
5. HIGH TEMPERATURE CAPACITIES, limited only by workability of high temperature alloys.



Wide Range of Sizes—TRANE Fluid Coolers are available in two models. The larger or vertical discharge model—Series GC—is made in 6 regular sizes with fan diameters ranging from 72″ to 144″. The smaller or horizontal discharge model—Series EC—comes in 14 sizes with fan diameters ranging from 18″ to 120″.

Left—TRANE Series EC Fluid Cooler. Main Illustration Above—TRANE Series GC Fluid Cooler.

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To obtain more information on products advertised see page E-51

HIGHLIGHTS IN OILDOM

CHEAPER DRILLING METHODS SOUGHT

The geologic structure of the Williston Basin area includes a number of sedimentary formations "which are very favorable for the accumulation of petroleum," Dr. Joseph J. Graham told shareholders of Bishop Oil Company at their annual meeting recently. The Stanford University Professor of Geology said that the present hunt for oil in that area is directed at finding promising geologic structures, which are close enough to the surface to make drilling economical.

Vice president William Wallace Mein, Jr., declared that development of the Williston Basin area is expected to be "slow", and added that Bishop is not planning to drill on any of its 23,000 acres of leased lands there at the present time.

GEORGIA PUBLISHES OIL LEAFLET

The Georgia Oil and Gas Commission has published a 4-page leaflet on oil possibilities in Georgia. Since the time the commission was formed in 1945 permits for the drilling of 24 exploratory wells have been granted, the Commission reports. Possibilities of oil productive areas are discussed by Garland Peyton, state geologist, Dr. Horace G. Richards, of the Academy of Natural Science of Philadelphia and the University of Pennsylvania, and Dr. H. W. Straley, Georgia Institute of Technology, and C. W. Deming, former director of the Georgia Oil and Gas Commission.

PE CLUB URGES CITIZENS TO VOTE

The Petroleum Engineers Club of Fort Worth is urging all citizens to go to the polls in the coming elections and vote for the candidates of their choice. The club has published a 16-page booklet discussing precinct, county, and state conventions, reminding the individual voter of some of the things he should do to arouse an interest in the coming elections.

VENEZUELAN OIL RESERVES RISE

Proved oil reserves continue to rise in Venezuela, members of the Interstate Oil Compact Commission were told at a meeting in Pheonix, Arizona, recently. Total reserves were set at more than 9 billion barrels, about 10 per cent of the world's reserves, with 832,800,000 bbl being added in 1951, by Carlso Perez de la Cova, in charge of petroleum affairs for the Venezuelan embassy in Washington, and F. Medina Oliveri, head of the production department for the Venezuelan minister of mines for Caracas. They added that total proved area in the country is 661,170 acres, or 4.3 per cent of the total area granted on concessions. Oliveri and Perez de la Cova stressed the facts that present reserves did not reveal the full extent of the oil wealth of Venezuela, and the fact that much of the potential oil land is not yet leased.

STEEL SHORTAGE CRITICAL

The steel situation in the oil industry may become critical if events bring about another strike. Bruce K. Brown, PAD administrator has reported that steel allotments for the third quarter were only 60 per cent of the operators' calculated requirements and the outlook for the fourth quarter was even more critical.

The Canadian oil industry, which obtains about 80 per cent of its steel supplies from the U. S., is facing the same desperate situation. Canadian operators had enough completion materials on hand for two months at the first part of May, but not enough drill pipe and other materials required in drilling operations. Drilling activities will be curtailed if steel mills are not kept running at top production levels, R. H. Gibbons of PAD reported.

OIL PRICE RAISE BATTLE SEEN IN OFFING

So far the Office of Price Stabilization has remained adamant in its refusal to grant higher prices in the oil industry on the basis that profits after taxes are large enough to absorb higher production costs. With the 15-cent hour raise in oil workers salaries, however, a new attempt may be made to bring the price structure upward. The Independent Petroleum Association of America is still waging its battle with OPS for removal of all price controls on the basis that controls are not justified at this time, and the new wage raise is adding fuel to its argument.

OIL FIRES INVESTIGATED

The Federal Bureau of Investigation agents are checking a series of tanker and rail fires involving large amounts of oil. In Wilmington, Delaware, an oil tanker loaded with 70,000 gal of high octane gasoline exploded in flames after colliding with a freighter. Thirty-five cars, many of them containing oil and gasoline were derailed near Corsicana, Texas, recently, resulting in a $3,000,000 loss. The coast area around Corpus Christi was imperiled later in the month when an 80,000-bbl tank of crude oil burst into flames.

NEW TRY FOR TIDELANDS CONTROL SEEN

Administration officials are reported seeking ways by which the tidelands can be taken over by executive order in case enough votes can be obtained to override the President's expected veto of the quit-claim bill. Government attorneys are expected to use the federal surplus property act passed in 1950, whereby the President could try to assume title and control of the tidelands and pass them over to the Interior Department for administration. Legality of such a move would almost certainly be challenged and would have to be settled by the courts in much the same manner as the steel plant seizure is being decided.

REFINERS STUDIES SMOG CAUSES

A new air-pollution theory was brought up at the API Refining Division's meeting in Los Angeles recently. The theory, as yet unproved, is that air pollution, known in Los Angeles as smog, is composed of the reaction products of the vapors of primary olefins having five to seven carbon atoms with an oxidant, presumably ozone. Although numerous objections have been raised to this theory, refiners were warned that they would be the brunt of criticism from pollution-control board, and the public. They were urged to check on their own refineries back home to find out what their evaporation losses are and where they can be eliminated or reduced.

HUMBLE INJUNCTION DENIED

Humble Oil and Refining Company's suit for an injunction to prevent Montgomery County, Texas, from raising mineral tax evaluations from $16,044,710 to $22,509,870 will not be reviewed by the Texas Supreme Court. Humble claimed the latter figure represents one-third of the market value.

OIL PROSPECTS SEEN IN OREGON

Prospects for discovery of commercial production of oil in Oregon are good, Ernest G. Ray, independent oil man reports in the *Tulsa Daily World*. A former Oklahoma oil man, Ray reports that prospects are especially good in the northwest region of Oregon.

SULFUR PRODUCTION LAGS

The International Materials Conference has estimated that total demand for sulfur this year will reach 14,000,000 tons, and world production is expected to total only 12,300,000 tons. World Demand is growing so rapidly that the government does not expect production to catch up until 1954, even with the tremendous help given by the oil industry. Total deficit last year was 1,272,000 tons.

LPG DEMAND ESTIMATES UP

Liquefied petroleum gas demand is expected to rise about 5.8 billion gallons in 1953, Petroleum Administration for Defense reports. This is 800,000,000 gal more than the demand estimated for the present year. Speaking before the Liquefied Petroleum Gas Association, Richard W. Walsh, PAD's natural gas producing and processing division director, reported that if the production rate of LPG continues at the 471,000,000 gal produced last January, there will be more than enough to meet the demand. The PAD spokesman added that new plants scheduled for 1952 completion will provide an additional output of one billion gallons a year and the 1953 rate of expansion is expected to be about the same as that of 1952.

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. . . with COOK Graphitic Iron Compression Rings

There are many factors that influence ring and cylinder wear. But one thing is sure . . . when you install Cook "Job-Engineered" Rings, you may expect longer ring and cylinder life. Why? Because the rings will have been engineered to correct the causes of the trouble, and, equally important, they will be made of Cook Graphitic Iron . . . a superior wear-resisting material. Write today for complete information.

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PISTON RINGS

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PETROLIC PERSONALITIES

DICK SNEDDON

ESSO EXECUTIVE HOT SAXOPHONIST

We were much impressed by the oil lore of J. C. Donnell, II, president and director of Ohio Oil Company, Findlay, Ohio, and vice president for production of API. An alumnus of Princeton, he handles a barrage of newsmen's questioning with very little disturbance. He does it all without even letting his pipe go out, and looks as if he were enjoying the experience. Among other visitors to the recent Los Angeles spring meeting were Carl Young and Bill Strang, the API production division chaps from Dallas, Texas; Dick Shaner from the New York office; and Herb Cooley, the Bethlehemite.

Ted Miles, the production chief of Continental Consolidated is over in Europe visiting his famous brother-in-law, Norval Franklin Myers, managing director of Esso Petroleum Company, Ltd. Norval is a lad who, if he hadn't made a complete success of his career as a chemical engineer, could probably have conducted a dance band. He can play a mighty hot sax.

NEW ENTERPRISES ARE BORN

M. D. "Dud" Hughes has resigned his position as chief engineer in charge of oil operations for the Long Beach Harbor Board and has opened offices as a consulting engineer in Long Beach. Dud has had an interesting time since he graduated from USC in 1932 with a degree in petroleum engineering. His first job was with Bill Pemberton when he was California Oil Umpire. He was later associated with Martin VanCouvering and then became an attache of Kettleman North Dome Association. For eight years he was with Long Beach Oil Development Company and since 1947 has been with the Harbor Board oil division. He is familiar with the Coastal Valley, and Los Angeles Basin fields and his direction of the subsidence investigations at the Harbor has been a valuable experience.

Dud does a bit of deep sea fishing in his spare moments, if any, and has the reputation of having landed the biggest hunk of kelp ever snagged by a local angler. Anyway, we are wishing Dud the best in his latest enterprise. And speaking of new ventures, Art Heiser, former vice president of Brown Drilling Company of Long Beach, has formed a partnership with D. W. Green, under the name Green and Heiser Drilling Company.

FLOTSAM AND JETSAM

By way of last minute news, Tommy Selser, the noted swordfish angler is back from Hawaii with a load of color sketches which he will convert to finished paintings as the opportunity presents. Ted Lynton writes from Valencia, Spain, that he is meeting lots of American geologists over there and wishes to extend his fond regards to the ones who couldn't make it. Ted is now stationed in Paris where he is with the Defense Materials Procurement Agency.

Paul Huggins had a pack of fun with his API speaking assignment. He announced that he had been allotted an hour and twenty minutes to cover his subject which was too much time to devote to any topic and he was, therefore, going to utilize some of the extra time to dissertate on the history of Kentucky, a matter with which he happened to be very familiar. Thereupon he produced a ponderous looking volume, properly entitled, and when he opened it up, it turned out to be the repository of a fifth of Kentucky bourbon and a couple of jiggers.

BIG GAME HUNTERS AND TRACKLESS SANDS

We bumped into Bill Pemberton, the noted African explorer, a few days ago, proceeding along Sixth Street, Los Angeles, in a series of bounds that would have done credit to an impala's pup. He was apparently late for Standard of Cal's pre-API cocktail party at the University Club and was hurrying desperately to catch up with the herd. Bill is just recently returned from the deeps of Africa where he startled the hartebeeste and other animals no end with non-interpretable outbursts of geologic imprecation and was probably the first hunter to ever stun big game animals with appropriate barbs from a well stocked vocabulary. We had just the night before seen Russ Havenstrite's exciting films of Kenya and Tanganita.

Incidentally, another interesting visitor to the Nomad meeting at which Russ Havenstrite exhibited his movie classic was Phil McConnell, the amiable production chief of the Arabian-American Oil Company, and an authority on Saudi Arabia. Phil told some right thrilling stories of the trackless sands out yonder and the difficulties of rescuing, by plane, parties that are not only thoroughly lost, but are practically invisible from the air because of enveloping sand storms.

OF HORTICULTURE AND OIL ROYALTIES

On the evening of the API banquet, Charlie Jones, Richfield Oil Corporation president; Sam Mosher, president of Signal Oil and Gas Company; Russ Green, Signal vice president; Jim Kelley, the Grover Kelley scion; and Charlie Hapgood, the Jones and Laughlin executive from back Pittsburgh way, were small talking about this and that. They took care of the camellia situation early in the proceedings and we learned by adept kibitzing that the camellia derives its name from a Jesuit priest, George Josef Camelli, who was the first to bring it out of the far east.

The conversation next veered from horticulture to oil royalties and Russ Green told a cute piece about a company executive who went to visit a lessor in the hope of getting some sort of concession from him. It seems that water encroachment was taking place very rapidly on his property; production was going down at an alarming rate, and the operation was barely paying for itself. When he came back from interviewing the lessor, he was asked what happened. "Well, sir," he said, "I gave him all the facts and ended with such an impassioned plea that I actually cried." "And what did he say after that?" inquired the chairman of the board. "He didn't say anything," replied the ambassador sadly, "*He* cried too."

ON THE OIL FRONT

"THIS IS ONE OF OUR RELAY STATIONS IN OUR PIPELINE CUMMUNICATIONS SYSTEM."

The proper bevel for the perfect weld!

M. W. KELLOGG

There's no particular trick to cutting a nozzle hole in a vessel when its location has been clearly indicated by a qualified layout man. But there is quite a trick to cutting these holes with the proper bevel to produce a perfect welded joint when the nozzle is attached. Perfection in such details is why "Kellogg-fabrication" is specified the industry's more important vessel orders.

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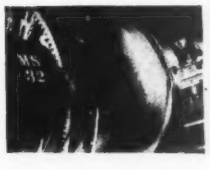
Continuing Study of behavior of metals under stress at high temperatures has produced valuable design data.

Shop Layout Craftsmen are fully experienced in vessel fabrication from nozzle positioning to "knockdown" fabrication for field assembly.



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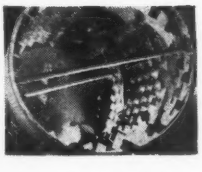
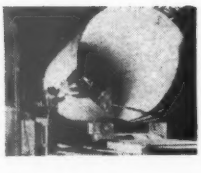


Extensive Facilities from bending of plate to final machining of precision surfaces permit complete fabrication under the same roof.



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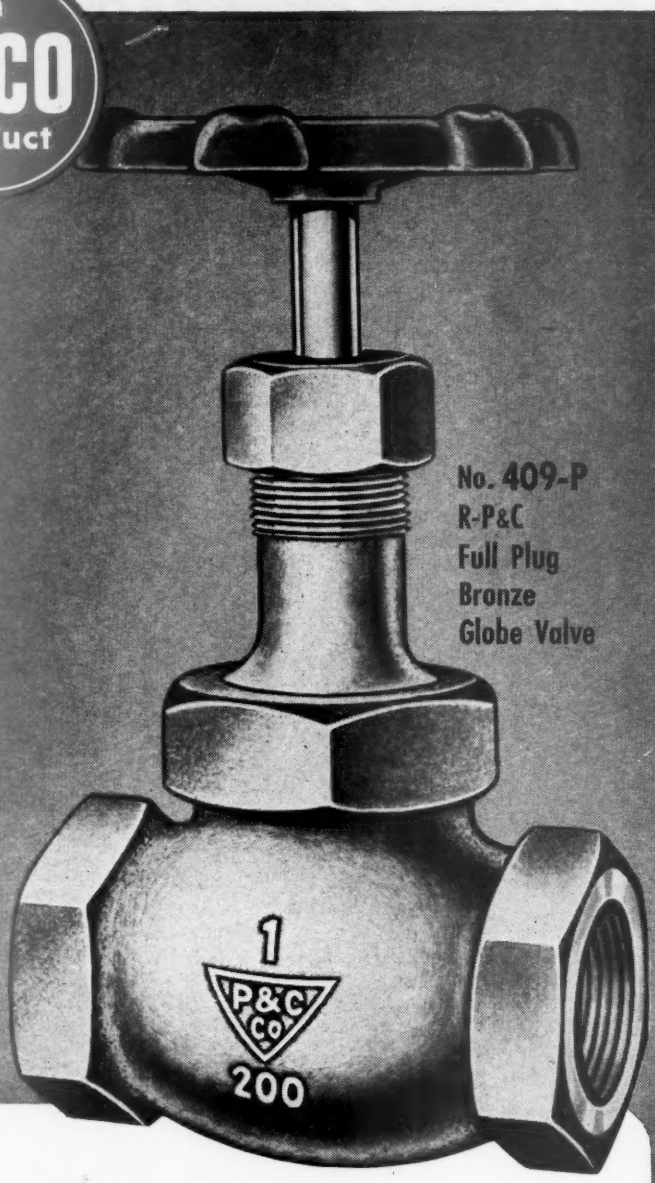

• High test bronze body and bonnet; nickel-alloy disc and seat ring; high tensile, high torque rolled bronze stem—plus large, deep stuffing box easily repacked under pressure—these are the features which make R-P&C Bronze semi-plug and full-plug Globe and Angle Valves outwear ordinary valves. They're fine for frequent or continuous throttling of steam, gas, oil, water. This type valve can be furnished in 200, 300 and 350 lb. pressures.

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Meetings

June 1-6—**Society of Automotive Engineers,** Ambassador and Ritz-Carlton, Atlantic City, New Jersey.

June 2-4—**Short Course on Process Instrumentation,** A. & M. College of Texas, College Station.

June 5-6—**Natural Gas and Petroleum Association of Canada,** Niagara Falls, Ontario.

June 5-6—**American Gas Association,** research and utilization conference, Hotel Statler, Cleveland, Ohio.

June 5-7—**National Society of Professional Engineers,** annual meeting, Tulsa, Oklahoma.

June 5-7—**National Oil Scouts and Landmen's Association,** annual convention, Hotel Hilton, Albuquerque, New Mexico.

June 7—**California Natural Gasoline Association,** annual June frolic, Rio Hondo Country Club, Downey, California.

June 8-12—**Canadian Gas Association,** Chateau Frontenac, Quebec City, Canada.

June 9-13—**Conference on Industrial Research,** Columbia University, New York City.

June 9-14—**American Petroleum Insitute,** midyear standardization conference, Brown Plaza Hotel, Denver, Colorado.

June 12-13—**Western Petroleum Refiners Association,** regional technical and industrial-relations meeting, Broadview Hotel, Wichita, Kansas.

June 13-14—**Rocky Mountain Oil and Gas Association,** midyear directors' meeting, Great Falls, Montana.

June 16-22—**International Gas Conference,** Brussels, Belgium.

June 22-27—**American Society for Testing Materials,** committeee on petroleum products and lubricants, New York, N. Y.

June 23-27—**American Society for Testing Materials,** annual meeting, Hotels Statler and New Yorker, New York City, New York.

July 1-Sept. 30—**Centennial of Engineering,** Museum of Science and Industry, Chicago.

Aug. 11-13—**Society of Automotive Engineers,** national West Coast meeting, Fairmont Hotel, San Francisco, California.

Aug. 25-27—**Appalachian Gas Measurement Short Course,** West Virginia University, Morgantown, West Virginia.

Aug. 31-Sept. 2—**Interstate Oil Compact Commission,** summer meet, Banff, Canada.

Sept. 3-5—**Pacific Coast Gas Association,** Ambassador Hotel, Los Angeles, California.

Sept. 4-5—**National Conference on Industrial Hydraulics,** Sherman Hotel, Chicago, Illinois.

Sept. 8-12—**National Instrument Conference and Exhibit,** Cleveland, Ohio.

Sept. 9-11—**Oil Industry Information Committee,** Traymore Hotel, Atlantic City, New Jersey.

DESK AND DERRICK CLUB

Dallas, Texas chapter, First Thursday of the Month.

Houston, Texas chapter, First Thursday of the Month.

Jackson, Mississippi chapter, Third Tuesday of the Month.

Los Angeles, California chapter, Third day of the Month.

Odessa, Texas chapter, First Monday of the Month.

Shreveport, Louisiana chapter, Second Tuesday of the Month.

NEW Weather-Protected Motor FOR Tough Outdoor Drives

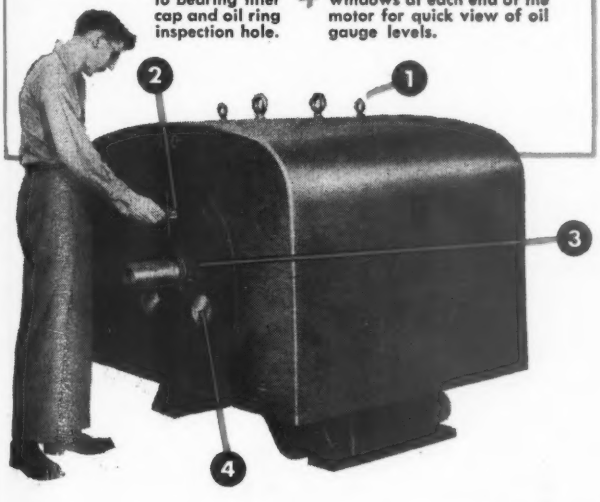
THIS IS HOW EASY "ACCESS" CAN BE

1 Lift steel protective hood easily by lifting eyes for periodic cleaning of motor.

2 Open knurled fastening locks quickly. Take door plate off for handy access to bearing filler cap and oil ring inspection hole.

3 Remove large plates to get at ends of the motor for bearing inspection or removal, air-gap measurement or blow-out of interior.

4 Look through plexi-glass windows at each end of the motor for quick view of oil gauge levels.



Look at this new E-M Weather-Protected Induction Motor, equipped with its own roof! You can set it up anywhere for exposed drive duty on pumps, draft fans, etc. Even with protection which holds off the weather's worst, access is simple and quick without dismantling the motor.

This new E-M "toughy" gets plenty of clean ventilating air, too. Intake air enters above motor feet at low velocity, is further slowed so that suspended particles are dropped before the rotor is reached. Special "blow-through" passages provide a by-pass for high velocity gusts of wind. Screens on all openings prevent entrance of refuse. Intake air filters are available.

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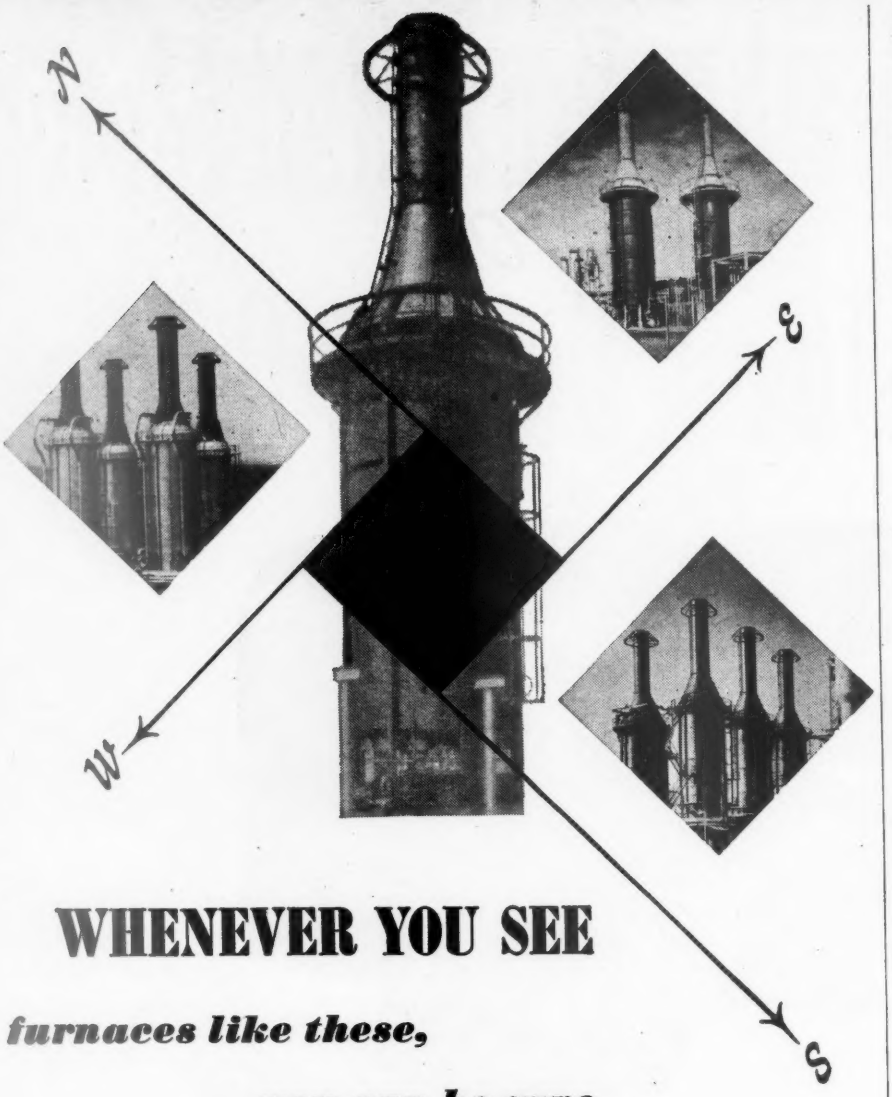

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Sept. 9-13—**National Chemical Exposition,** Chicago Coliseum, Illinois.

Sept. 10—**American Petroleum Institute,** lubrication committee, Traymore Hotel, Atlantic City, New Jersey.

Sept. 10-12—**National Petroleum Association,** annual meeting, Hotel Traymore, Atlantic City, New Jersey.

Sept. 11-13—**American Institute of Chemical Engineers,** Palmer House, Chicago

Sept. 14-19—**American Chemical Society,** petroleum division, Traymore Hotel, Atlantic City, New Jersey.

Sept. 22-24—**American Society of Mechanical Engineers,** petroleum division conference, Hotel President, Kansas City, Missouri.

Sept. 23-24—**American Petroleum Institute,** executive committee and board of directors, Greenbrier Hotel, White Sulphur Springs, West Virginia.

Sept. 28-30—**American Association of Oilwell Drilling Contractors,** annual meeting, Skirvin Hotel, Oklahoma City, Oklahoma.

Oct. 1-3—**American Institute of Mining and Metallurgical Engineers,** petroleum branch, Mid-Continent fall meeting, Rice Hotel, Houston, Texas.

Oct. 1-3—**National Association of Corrosion Engineers,** south central region, Jung Hotel, New Orleans, Louisiana.

Oct. 4—**John Zink process heating seminar,** John Zinc Company, Tulsa, Oklahoma.

Oct. 6—**Independent Natural Gas Association of America,** annual meeting, Fontenelle Hotel, Omaha, Nebraska.

Oct. 13-15—**Texas Mid-Continent Oil and Gas Association,** thirty-third annual meeting, Fort Worth, Texas.

Oct. 19—**Natural Gasoline Association of America,** southern regional meeting, Blackstone Hotel, Tyler, Texas.

Oct. 20-21—**Independent Petroleum Association of America,** annual meeting, Tulsa.

Oct. 23-24—**American Institute of Mining and Metallurgical Engineers,** West Coast fall meeting, Statler Hotel, Los Angeles, California.

Oct. 27-30—**American Gas Association,** annual convention, Atlantic City, New Jersey.

Oct. 30-Nov. 1—**Rocky Mountain Oil and Gas Association,** annual meeting, Cosmopolitan Hotel, Denver, Colorado.

Nov. 10-13—**American Petroleum Institute,** annual meeting, Chicago, Illinois.

Dec. 1-6—**National Exposition of Power and Mechanical Engineering,** Grand Central Palace, New York City, N. Y.

Dec. 7-10—**American Institute of Chemical Engineers,** annual meeting, Hotels Cleveland and Carter, Cleveland, Ohio.

NOMADS TO MEET

New York, N. Y., Chapter, First Monday of the Month, Louis Sherry's, New York. Secretary, Jesse E. Hickman.

Houston Chapter, Second Monday of the Month, Ye Olde College Inn, Houston, Texas. Secretary Harry E. Estes.

Los Angeles Chapter, Second Wednesday of the Month, Jonathan Club, Los Angeles, Calif. Secretary Jack Ballagh.

Tulsa Chapter, Third Friday, "After Five" Room, Hotel Tulsa. Secretary Gilbert Swift.

Dallas-Fort Worth Chapter, Dallas, Texas. First Monday of the Month. Secretary M. W. Hiltpold.

To obtain more information on products advertised see page E-51

GRAVITY OF DRY OIL IN OIL-WATER MIXTURE, DEG. A.P.I.

Gravity of "wet" oil deg. A.P.I.	Percent water in mixture														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
50.0	50.5	51.1	51.6	52.2	52.7	53.3	53.9	54.6	55.2	55.9	56.6	57.3	**58.0**	58.8	59.5
.1	.6	.2	.7	.3	.9	.5	54.1	.7	.4	56.1	.8	.5	.2	**59.0**	.7
.2	.7	.3	.8	.4	**53.0**	.6	.2	.8	.5	.2	.9	.6	.3	.1	.8
.3	.8	.4	.9	.5	.1	.7	.3	.9	.6	.3	**57.0**	.7	.4	.2	**60.0**
.4	.9	.5	**52.0**	.6	.2	.8	.4	**55.0**	.7	.4	.1	.8	.5	.3	.1
50.5	**51.0**	51.6	52.1	52.7	53.3	53.9	54.5	55.1	55.8	56.5	57.2	57.9	58.6	59.4	60.2
.6	.2	.8	.3	.9	.5	54.1	.7	.3	**56.0**	.7	.3	58.1	.8	.6	.4
.7	.3	.9	.4	**53.0**	.6	.2	.9	.5	.2	.9	.5	.3	**59.0**	.8	.6
.8	.4	**52.0**	.5	.1	.7	.3	**55.0**	.6	.3	**57.0**	.6	.4	.2	.9	.7
.9	.5	.1	.6	.2	.8	.4	.1	.7	.4	.1	.8	.5	.3	**60.0**	.8
51.0	51.6	52.2	52.7	53.3	53.9	54.5	55.2	55.8	56.5	57.2	57.9	58.6	59.4	60.1	60.9
.1	.7	.3	.8	.4	**54.0**	.6	.3	.9	.6	.3	**58.0**	.8	.6	.3	**61.0**
.2	.8	.4	.9	.5	.1	.7	.4	**56.0**	.7	.4	.1	.9	.7	.4	.2
.3	.9	.5	**53.0**	.6	.2	.8	.5	.1	.8	.5	.2	**59.0**	.8	.5	.4
.4	**52.0**	.6	.1	.7	.3	.9	.6	.2	.9	.6	.4	.1	.9	.6	.5
51.5	52.1	52.7	53.2	53.8	54.4	**55.0**	55.7	56.3	**57.0**	57.7	58.5	59.2	**60.0**	60.7	61.6
.6	.2	.8	.3	.9	.5	.2	.8	.5	.2	.9	.6	.4	.2	.9	.8
.7	.3	.9	.4	**54.0**	.6	.3	.9	.6	.3	**58.0**	.7	.5	.3	**61.0**	.9
.8	.4	**53.0**	.5	.1	.7	.4	**56.0**	.7	.4	.1	.8	.6	.4	.2	**62.0**
.9	.5	.1	.6	.2	.8	.5	.1	.8	.5	.2	.9	.7	.5	.3	.1
52.0	52.6	53.2	53.7	54.3	54.9	55.6	56.2	56.9	57.6	58.3	**59.0**	59.8	60.6	61.4	62.2
.1	.7	.3	.8	.4	**55.0**	.7	.4	**57.0**	.7	.5	.2	**60.0**	.8	.6	.4
.2	.8	.4	.9	.5	.2	.8	.5	.1	.8	.6	.3	.1	.9	.7	.5
.3	.9	.5	**54.0**	.6	.3	.9	.6	.2	.9	.7	.4	.2	**61.0**	.8	.6
.4	**53.0**	.6	.1	.7	.4	**56.0**	.7	.3	**58.0**	.8	.5	.3	.1	.9	.7
52.5	53.1	53.7	54.2	54.8	55.5	56.1	56.8	57.4	58.1	58.9	59.6	60.4	61.2	**62.0**	62.8
.6	.2	.8	.4	**55.0**	.7	.3	**57.0**	.6	.3	**59.0**	.8	.6	.4	.2	**63.0**
.7	.3	.9	.5	.1	.8	.4	.1	.8	.5	.2	**60.0**	.8	.6	.4	.2
.8	.4	**54.0**	.6	.2	.9	.5	.2	.9	.6	.3	.1	.9	.7	.5	.3
.9	.5	.1	.7	.3	**56.0**	.6	.3	**58.0**	.7	.4	.2	**61.0**	.8	.6	.4
53.0	53.6	54.2	54.8	55.5	56.1	56.8	57.5	58.1	58.9	59.6	60.4	61.2	**62.0**	62.8	63.6
.1	.7	.3	.9	.6	.2	.9	.6	.2	**59.0**	.7	.5	.3	.1	.9	.8
.2	.8	.4	**55.0**	.7	.3	**57.0**	.7	.3	.1	.8	.6	.4	.2	**63.0**	.9
.3	.9	.5	.1	.8	.4	.1	.8	.4	.2	.9	.7	.5	.3	.1	**64.0**
.4	**54.0**	.6	.2	.9	.5	.2	.9	.5	.3	**60.0**	.8	.6	.4	.2	.1
53.5	54.1	54.7	55.3	**56.0**	56.5	57.3	**58.0**	58.7	59.4	60.2	**61.0**	61.8	62.6	63.4	64.3
.6	.2	.8	.4	.1	.7	.5	.1	.8	.5	.3	.1	.9	.7	.5	.4
.7	.3	.9	.5	.2	.8	.5	.2	.9	.6	.4	.2	**62.0**	.8	.6	.5
.8	.4	**55.0**	.6	.3	.9	.6	.3	**59.0**	.7	.5	.3	.1	.9	.7	.6
.9	.5	.1	.7	.4	**57.0**	.7	.4	.1	.8	.6	.4	.2	**63.0**	.8	.7
54.0	54.6	55.2	55.8	56.5	57.1	57.8	58.5	59.3	**60.0**	60.8	61.6	62.4	63.2	**64.0**	64.9
.1	.7	.3	.9	.6	.2	.9	.6	.4	.1	.9	.7	.5	.3	.2	**65.0**
.2	.8	.4	**56.0**	.7	.3	**58.0**	.7	.5	.2	**61.0**	.8	.6	.4	.4	.2
.3	.9	.5	.1	.8	.4	.1	.8	.6	.3	.1	.9	.7	.5	.5	.3
.4	**55.0**	.6	.2	.9	.5	.2	.9	.7	.4	.2	**62.0**	.8	.6	.6	.4
54.5	55.1	55.7	56.3	**57.0**	57.6	58.3	**59.0**	59.8	60.5	61.3	62.1	62.9	63.7	64.7	65.5
.6	.2	.8	.4	.1	.7	.4	.1	.9	.6	.4	.2	**63.0**	.8	.8	.6
.7	.3	.9	.5	.2	.8	.5	.2	**60.0**	.7	.5	.3	.1	.9	.9	.7
.8	.4	**56.0**	.6	.3	.9	.6	.3	.1	.8	.6	.4	.2	**64.0**	**65.0**	.8
.9	.5	.1	.7	.4	**58.0**	.7	.4	.2	.9	.7	.5	.3	.1	.1	.9

GRAVITY OF DRY OIL IN OIL-WATER MIXTURES, DEG. A.P.I.

Gravity of "wet" oil, deg. A.P.I.	Percent water in mixture									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
20.0	20.01	20.02	20.03	20.04	20.05	20.06	20.07	20.09	20.10	20.11
.1	.11	.12	.13	.14	.15	.16	.17	.18	.19	.21
.2	.21	.22	.23	.24	.25	.26	.27	.28	.29	.30
.3	.32	.33	.34	.35	.36	.37	.39	.40	.41	.42
.4	.42	.43	.44	.45	.46	.47	.48	.50	.51	.52
20.5	20.51	20.53	20.54	20.55	20.56	20.57	20.58	20.59	20.61	20.62
.6	.61	.62	.64	.65	.66	.67	.68	.69	.71	.72
.7	.71	.72	.73	.75	.76	.77	.78	.79	.80	.82
.8	.81	.82	.83	.84	.86	.87	.88	.89	.90	.92
.9	.91	.92	.93	.94	.96	.97	.98	.99	**21.00**	21.01
21.0	21.01	21.02	21.03	21.04	21.06	21.07	21.08	21.09	21.10	21.11
.1	.11	.12	.13	.14	.16	.17	.18	.19	.20	.21
.2	.21	.22	.23	.24	.26	.27	.28	.29	.30	.31
.3	.32	.33	.34	.36	.37	.38	.39	.41	.42	.43
.4	.42	.43	.44	.46	.47	.48	.49	.51	.52	.53
21.5	21.52	21.53	21.54	21.56	21.57	21.58	21.59	21.61	21.62	21.63
.6	.62	.63	.64	.66	.67	.68	.69	.71	.72	.73
.7	.72	.73	.74	.76	.77	.78	.79	.81	.82	.83
.8	.82	.83	.84	.86	.87	.88	.89	.91	.92	.93
.9	.92	.93	.94	.96	.97	.98	**22.00**	22.01	22.02	22.03
22.0	22.02	22.03	22.04	22.06	22.07	22.08	22.10	22.11	22.12	22.14
.1	.12	.13	.14	.16	.17	.18	.20	.21	.22	.24
.2	.22	.23	.24	.26	.27	.28	.30	.31	.32	.34
.3	.32	.33	.34	.36	.38	.39	.40	.41	.43	.44
.4	.42	.43	.44	.46	.48	.49	.50	.51	.53	.54
22.5	22.52	22.53	22.55	22.56	22.58	22.59	22.60	22.62	22.63	22.64
.6	.62	.63	.65	.66	.68	.69	.70	.72	.73	.74
.7	.72	.73	.75	.76	.78	.79	.80	.82	.83	.85
.8	.82	.84	.85	.86	.88	.89	.91	.92	.93	.95
.9	.91	.92	.93	.95	.97	.98	.99	23.01	23.02	23.03
23.0	23.01	23.02	23.04	23.05	23.07	23.08	23.09	23.11	23.12	23.14
.1	.11	.12	.14	.15	.17	.18	.20	.21	.22	.24
.2	.21	.22	.24	.25	.27	.28	.30	.31	.33	.34
.3	.31	.33	.34	.36	.38	.38	.40	.41	.43	.44
.4	.41	.43	.44	.46	.48	.49	.50	.52	.53	.55
23.5	23.52	23.53	23.55	23.56	23.58	23.59	23.60	23.62	23.63	23.65
.6	.62	.63	.65	.66	.68	.69	.71	.72	.74	.75
.7	.72	.73	.75	.76	.79	.80	.81	.83	.84	.86
.8	.82	.84	.85	.87	.89	.90	.91	.93	.94	.96
.9	.91	.92	.94	.95	.97	.98	**24.00**	24.02	24.03	24.05
24.0	24.01	24.03	24.04	24.06	24.08	24.09	24.10	24.12	24.13	24.15
.1	.11	.13	.14	.16	.18	.19	.21	.22	.24	.25
.2	.22	.23	.25	.26	.28	.29	.31	.33	.34	.36
.3	.32	.33	.35	.37	.39	.40	.41	.43	.45	.46
.4	.42	.44	.45	.47	.49	.50	.52	.53	.55	.57
24.5	24.51	24.52	24.54	24.56	24.58	24.59	24.60	24.62	24.64	24.65
.6	.61	.63	.64	.66	.68	.69	.71	.72	.74	.76
.7	.71	.73	.75	.76	.79	.80	.81	.83	.85	.86
.8	.82	.83	.85	.87	.89	.90	.92	.93	.95	.97
.9	.92	.94	.96	.97	.99	**25.00**	25.02	25.04	25.06	25.07

Gravity of dry oil in oil water mixture, deg. A.P.I. with percent water in mixture less than one suggested by R. W. Miller, Phillips Petroleum Company, Oklahoma City, Oklahoma.

See PEERLESS FIRST!
For GAS SCRUBBERS...
An installation of two 48 x 19 Peerless Scrubbers, each handling 50 million cubic ft. of gas a day at 250 PSI on the inlet of a power plant in South Texas.

The *BEST SCRUBBERS* for PIPELINES, GATHERING SYSTEMS, COMPRESSOR STATIONS, PLANT INLET SCRUBBERS

With Peerless Scrubbers you can rely on Maximum Efficiency with Minimum Pressure Drop. These precision engineered scrubbers are available in both vertical and horizontal sizes or can be built to your requirements . . . For Any Gas Flow . . . For Any Working Pressure.

Each Peerless Scrubber is designed and built around the famous Peerless Mist Extractor Unit, which guarantees the liquid entrainment loss to be less than 1/10 gal. per million standard cubic feet of flowing gas.

PEERLESS MFG. CO.

PEERLESS MANUFACTURING CO.

P. O. BOX 7193 ★ DALLAS, TEXAS ★ DIxon-8431

REPRESENTATIVES IN ALL PRINCIPAL CITIES

REPUBLIC NATIONAL BANK
OF DALLAS, TEXAS

Statement of Condition, March 31, 1952

RESOURCES

Cash and Due from Banks	$151,132,320.59
U. S. Government Securities	57,276,238.50
State, Municipal and Other Securities	2,821,274.86
Stock in Federal Reserve Bank	1,275,000.00
Loans and Discounts	218,064,506.34
Bills of Exchange and Commodity Loans	20,179,196.43
Real Estate — New Building and Equipment	5,199,238.00
Acceptances — Customers Account	10,938,653.92
Total	$466,886,428.64

LIABILITIES

Capital	$ 21,000,000.00	
Surplus	21,500,000.00	
Undivided Profits	4,868,105.40	47,368,105.40
Reserve for Monthly Dividend, Payable April 1, 1952		199,500.00
Reserve for Contingencies		3,518,970.49
Reserve for Taxes, Etc.		2,828,621.91
Acceptances — Customers Account		11,163,653.92
Deposits:		
Individual	264,481,005.94	
Banks	117,036,835.80	
Government	20,289,735.18	401,807,576.92
Total		$466,886,428.64

☆ ☆ ☆

Assets of the Republic National Company, with capital stock of $3,000,000, are not included in above statement. The Company owns controlling stock in the following banks located in Greater Dallas, all affiliated with Republic National Bank:

FAIR PARK NATIONAL BANK — LAKEWOOD STATE BANK
GREENVILLE AVENUE STATE BANK — NATIONAL CITY BANK
HIGHLAND PARK STATE BANK — OAK CLIFF BANK & TRUST CO.
OAK LAWN NATIONAL BANK

Resources of the Republic National Bank and Affiliated Banks aggregate $578,847,089.43

"Well Bank" ...the strong, friendly bank

MEMBER FEDERAL DEPOSIT INSURANCE CORPORATION

LETTERS

Fire Control

To The Petroleum Engineer:

An article by J. L. Risinger entitled "New Fire Control Method," appearing in your issue of February 1952, describes a "new" method of controlling oil fires by agitation, said to have been developed on behalf of the Socony-Vacuum Oil Company, Inc. As the author appears to be unacquainted with the work on the same subject already done in Great Britain, attention is drawn to the publication by J. H. Burgoyne and L. L. Katan in the Journal of the Institute of Petroleum 1947, vol. 33, p. 158 (March), in which the principles and applications of the technique of agitation are examined in some detail. The experiments described were carried out on behalf of the Ministry of Home Security and the Department of Scientific and Industrial Research, at Imperial College, London, and at the Llandarcy installation of National Oil Refineries, Ltd., during the years 1943 to 1946.

The desirability of extending the work of Burgoyne and Katan with experiments on the large scale has since been stressed (see for example *Oil* 1950, vol. 1, No. 9, p. 12) and the American tests are to be welcomed as a move in this direction. At the present stage, however, the technique of agitation can no longer be described as "new."

J. H. Burgoyne
Imperial College of Science and Technology,
London, England.

School Benefits

To The Petroleum Engineer:

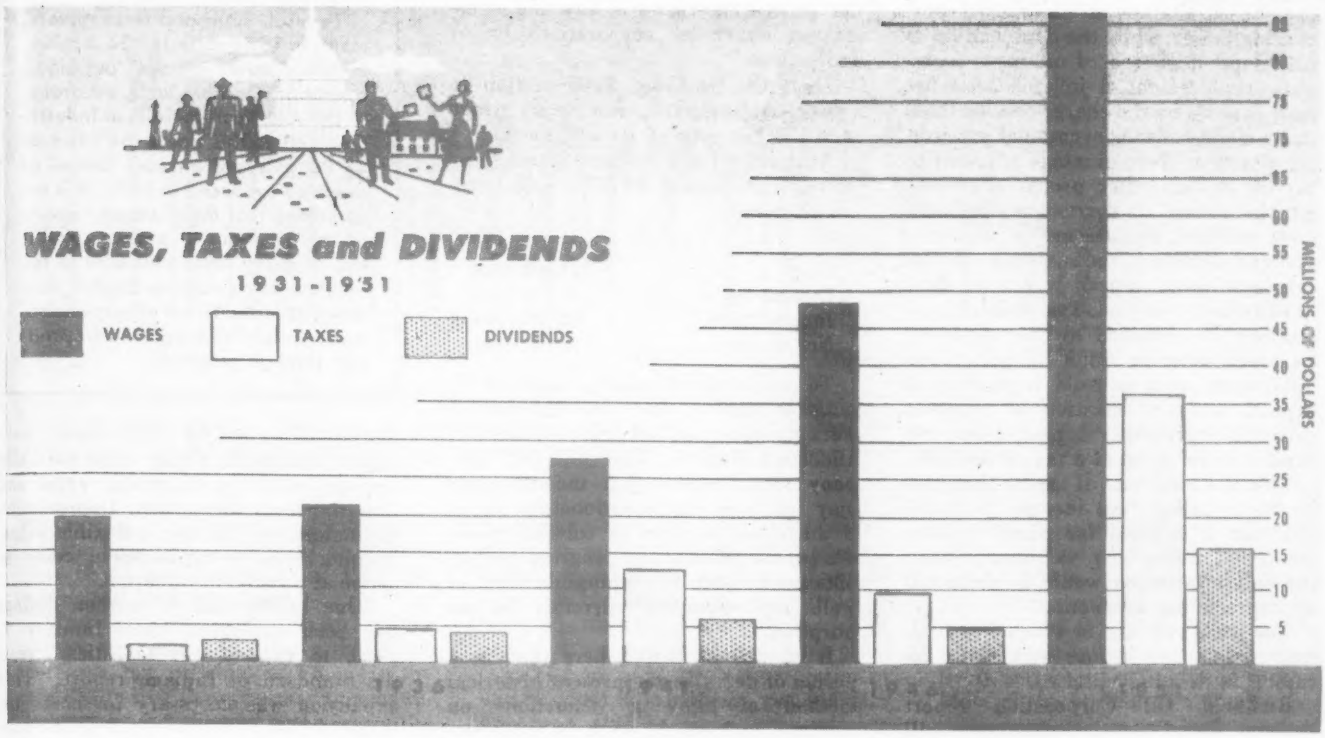
Since we are all pretty well swamped with work, and our nearest office is 40 miles from here, we all forgot to renew the subscription to *The Petroleum Engineer*. We are getting quite a field around Lovington. The magazine I get is really used up. I turn it over to the school here when I am done with it. The students in school now are the ones in the field tomorrow.

R. E. Dendy
District Engineer
Texas-New Mexico Pipe Line Company
Lovington, New Mexico

WHITE HOUSE BUDGET

President	No. Employees	Salaries
Harding 1923	31	$ 150,000
Roosevelt 1944	53	$ 256,000
Truman 1951	293	$1,700,000

To obtain more information on products advertised see page E-51



Atlantic Refining shows how the rise in wages, taxes, and dividends each 5 years since 1931 has been felt by the company. Taxes represent only direct tax. Add taxes on products and the total is more than the entire amount paid in wages.

"Prosperity" Costs Too Much

Annual reports of petroleum companies show capital expenses greater than net income and deductions unrealistically low

ERNESTINE ADAMS*

THIS "prosperity" we are having looks like a Certified Public Accountant's theory of relativity. National income is increased by giving a buyer less for his dollar and what can't be paid for that way is charged to the local, state, and federal debt, presumably to be paid by future generations.

This "prosperity" in the oil industry does not provide a large enough total net income to pay for the expense of replacing its worn or obsolete plant and expanding to meet the consumer demand.

An examination of fifty odd annual financial reports of oil and gas companies for 1951 and the first quarter of 1952 shows the oil industry suffering from the strains and stresses of inflation and taxation and the corrosion of extensive controls. Next year's reports will show the full effect of additional tax burdens, which began late in 1951.

Stuart Symington, a Democrat in good standing, said in speech he made for the senatorial nomination in Missouri:

"It is trite but true that the United States can be destroyed internally through economic chaos just as certainly as it can be destroyed externally through defeat by armed forces. The destruction of our way of life could occur, and the communists must be becoming more confident it will occur, without their being forced into an all-out atomic war.

"Perhaps the politburo will now rely on their silent weapons, such as crippling taxes, unprecedented spending, inflationary tendencies, and the consequent dulling of that personal incentive and managerial initiative so essential to our way of life.

"These silent weapons can be just as lethal as noisy cannon. They are also very, very cheap for the communists, because we first create them and then discharge them against ourselves."

A number of annual reports protest the price ceiling on oil and gas. It is true that oil products, under present conditions, are too low but the industry and the nation would best be served when inflation is halted, taxation is sane, and controls are the controls of supply and demand and of conservation regulation.

To a layman the financial reports in

*Managing Editor.

EXCLUSIVE

devaluated dollars are unrealistic. The Gulf Oil report states: "These earnings require a critical eye, for they are expressed in dollars of diminished purchasing power, while the depreciation of plant and depletion of oil reserves require replacement at inflated costs not fully covered by the charge-offs for these items made under conventional accounting practice. Were earnings adjusted to prewar dollars, after proper allowance for the excess of current replacement costs over the deductions for depreciation and depletion, the resulting smaller earnings would appear in a truer light in relation to the past. Two striking conclusions are justified by this analysis: Earnings must be 'high' in periods of inflation in order to avoid destruction of capital, and the taxation of reported earnings represents, in part, a levy on capital in the guise of a tax on income."

This is a mild way of saying that part of the so-called "net income" is taxed although it is used for plant replacement and under any valuation except the dollar valuation would be deducted as depreciation allowance.

The period of time in which a capitalistic system can endure with a tax on capital is definitely limited.

Richfield Oil Corporation report states: "The Federal Government will siphon off more than 75 per cent of the increased earnings (for 1951)." Unless the upward trend of tax rates is stopped, the report asserts, "There will be no earnings, after taxes, to put back into the business, and no industrial growth for private enterprise in any line of endeavor either by corporations or by individuals."

Shell Oil paid out $146 million in capital expenditures last year, which was 150 per cent of its net income.

Ashland Oil and Refining shows these percentages figures for 1951, which are enlightening:

	Above 1950
Sales	41 per cent
Income before taxes	38 per cent
Income taxes	68 per cent
Net income	12 per cent

To obtain the allowances made for intangible drilling costs the industry is working under the adverse conditions of allocation controls. The Ohio Oil Company report states that income taxes may increase disproportionately for it, if adequate supplies of tubular goods needed for the drilling program are unobtainable since the intangible costs of wells are "expensed" currently for tax purposes.

It should be stated here that in a period of deflation the present historical method of allowing deductions on original costs would work in the opposite direction and would be as deceptive as it is now in a period of inflation. A company then would receive as much or more than needed for replacement, making the tax less at a time when normally revenue would be of greater value and importance to the nation. Depreciation deductions should have a flexible value, keeping close to replacement costs, to arrive at a realistic valuation.

"One billion and 75 million dollars has been expended since January 1, 1946, to expand our facilities," read the Standard of Indiana report. "This expansion was necessary to meet customer demand. It also resulted in more jobs at better wages, and in higher earnings and dividends.

"Of the billion dollars-plus, 456 million dollars came from plowing back earnings, but there was a net increase in borrowings of 235 million dollars during this period."

Then the report points out the other side of the picture: "Book value per share of stock increased from $53.63 at the end of 1945 to $83.00 at the end of 1951. The value of the underlying assets based on replacement costs has increased even more rapidly."

The present trend would have to be stopped or reversed, however, to realize gain from the inflationary valuation of assets. It is asking a lot to be optimistic about higher dollar value of old plants that may have to be replaced at still higher dollar cost.

The accelerated tax amortization allowed by special permission of DPA on plants deemed particularly advisable is acknowledgment of the importance of a more equitable depreciation deduction but this granting of certificates for depreciation charge-off over a 5-year period as used now is a manipulating device that could be a political as well as an economical restriction.

Quaker State Oil Refining Corporation goes into the growing threat of one specific tax:

"Excess profits tax laws were enacted in the United States during the two world wars. The laws were based on the principle of taxing profits arising from war. The tax was, therefore, levied on profits accruing to a corporation in excess of earnings enjoyed during a prewar or base period. The present law departs from that principle. In 1950 the tax was levied on earnings in excess of

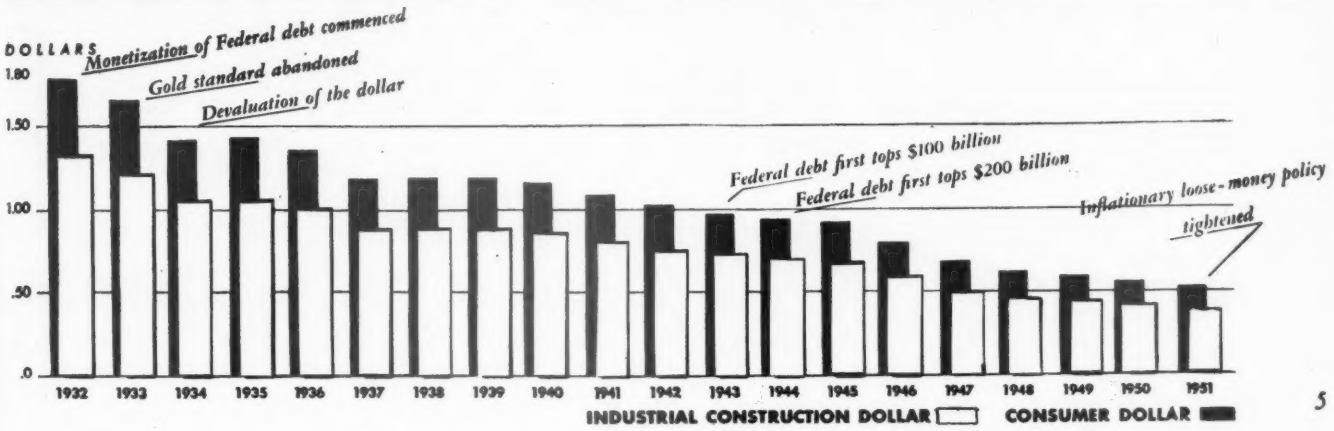
TABLE 1. Deductions vs expenditures.

	Allowed for depreciation and depletion*	Capital exp, 1951	Net earnings 1951	% Dividend yield paid to stockholders
Amerada	29,000,640	33,925,000	16,296,652	2.0
American Republics	3,426,275	6,245,135	4,753,689	3.3
Anderson-Prichard	3,721,654	8,201,211	4,846,890	3.1+
Argo Oil	528,566	869,007	3,534,710	3.2
Ashland	8,701,299	22,594,203	12,137,972	5.4
Atlantic Refining	30,718,981	71,327,000	45,067,000	5.3+
Bishop Oil	351,815	576,982	407,714	1.7+
British American	8,529,884	33,219,000	13,099,301	2.3
Cities Service	50,629,347	82,000,000	57,177,000	4.9
Continental Oil	49,577,484	88,747,961	41,292,692	4.5
Cosden Petroleum	738,084	1,698,632	2,748,997	5.4
Creole Petroleum	48,213,437	54,816,358	202,278,299	7.9
Deep Rock	2,414,853	4,445,000	2,241,000	3.5
General American	1,921,882	5,309,005	4,477,269	1.1+
Gulf Oil	111,671,000	176,287,000	140,071,000	3.7
Hancock Oil of California	2,538,705	1,077,223	3,009,902	1.2
Houston Oil	3,501,217	12,040,326	7,053,640	3.7
Humble Oil and Ref.	56,109,163	158,793,800	169,480,626	3.9
Imperial Oil Ltd	15,980,059	57,208,751	35,951,153	1.8
Lion Oil	5,911,091	16,299,012	11,751,026	4.8
Mid-Continent Petroleum	11,643,981	15,287,185	17,062,182	5.4
Ohio Oil	17,338,631	38,117,000	41,681,663	5.9
Pan-American	10,158,215	21,350,453	24,286,431	5.1
Panhandle Prod. and Ref.	1,360,043	840,000	1,352,621	3.8+
Phillips Petroleum	59,730,979	160,180,031	73,711,229	4.7
Plymouth Oil	5,028,000	8,714,000	10,295,791	4.9
Pure Oil	20,587,245	31,000,000	33,593,727	4.0
Quaker State Oil Ref.	1,960,427	3,573,507	2,148,036	6.2+
Richfield	15,490,137	27,463,650	28,218,281	5.6+
Shamrock Oil and Gas	2,049,888	5,745,613	5,204,070	6.2
Shell Oil	108,167,833	145,714,000	97,020,000	4.4
Signal Oil and Gas	6,463,896	5,846,059	8,549,329	1.7
Sinclair Oil	54,596,306	118,335,000	81,898,490	5.9
Skelly Oil	20,092,715	43,251,436	31,074,985	3.3+
Socony-Vacuum†	99,037,705	176,197,000	161,622,000	4.5+
South Penn Oil Company	4,272,000	5,031,339	8,734,403	7.7
Standard of California	120,095,717	182,000,000	173,341,211	5.1
Standard of Indiana	86,972,000	183,100,000	148,700,000	3.4+
Standard of New Jersey	207,940,000	381,824,000	528,461,000	5.3
Sun Oil	55,184,613	48,700,000	45,353,643	1.3+
Sunray Oil	26,696,864	36,047,891	24,282,516	5.8
Superior Oil	28,332,038	40,635,000	13,295,639	0.8
Texas Company	135,074,393	177,041,534	178,774,677	6.0
Texas Pacific Coal and Oil	5,189,140	5,471,880	6,824,124	4.0
Tide Water Associated	27,578,575	32,609,904	37,060,606	5.2
Union Oil of California	40,281,003	62,420,928	27,295,971	5.3
United Gas	15,996,000	113,309,831	18,312,946	4.1
Universal Consolidated	209,400	1,035,608	2,531,467	7.1+
Wilcox Oil	896,789	1,101,075	860,004	5.8+

†Means plus stock.
*Usually includes total intangible development costs or amortization, abandonments, etc.

Petroleum Industry Taxed $4.5 Billion in '51

Federal, state and local governments in 1951 collected $4.5 billion in taxes levied against petroleum operations and products, according to the American Petroleum Industry Committee. This tax is the same as $1.86 assessed on each barrel of crude oil produced in 1951. It is not surprising that these annual reports of the oil industry protest against the crippling taxes that must in the end turn away venture capital, slow down operations, cut off expansion, and deprive the nation of new products through research.



Sun Oil Company's comprehensive chart on the effects of inflation shows the value of the 1926 dollar in terms of consumer and industrial purchasing power over a 20-year period. In order to meet the mounting demand the industry must replace and modernize worn and obsolete facilities at prices as much as 2⅓ times the original cost.

85 per cent of the average earnings during the base period; in 1951 on the excess of 84 per cent, and in 1952 the figure will be 83 per cent.

"Rising costs, with fixed selling prices, are certain to cause a shrinkage in these tax collections. There is the possibility that Congress may then again lower the base, thereby accelerating the confiscation already underway."

Expansion Demanded

It is ironical that the demand for expansion comes from the same Federal government that is taxing the capital necessary for expansion. Several company reports state that the companies are cooperating with the government-sponsored program for increasing by one million barrels a day in Western Hemisphere potential crude oil production and refining capacity.

The Texas Company report adds:

"Excessive taxation is the most serious problem facing all industry today. In 1951, the tax burden upon users of petroleum products was substantially increased. Because of the increased Federal gasoline tax, the new diesel fuel tax, and higher taxes on the purchases of motor vehicles and parts, the users of petroleum products will have to pay about 45 per cent of the estimated tax increase represented by increased Federal excise taxes. We feel that consumers of petroleum products are required to bear an unfair proportion of the total tax burden.

"Despite an expected increase in demand for petroleum products in 1952, the outlook for earnings is uncertain. With present controlled prices, increased taxes, higher payrolls and other expenses, Texaco may be faced with lower earnings in 1952 than in 1951."

The funds for the government-sponsored expansion comes from the so-called "profits", reduced dividends to stockholders, borrowing, and drawing upon cash reserves.

The report of Atlantic Refining states:

"The very high and growing amount of capital investment which we and the whole petroleum industry have been required to make in recent years has resulted from three factors. First, of course, is the inflation of the price level. Second is the continuous introduction of new and more efficient tools and processes. By its willingness to experiment and to adopt new methods, our industry has been able to make extraordinary progress in increasing output, but, by the same token, it has been forced to abandon much investment as obsolescent long before it is worn out physically. Third, and most important, is the continued rapid rise in demand for our products. Even with the substantial additions to productive capacity which have been made, the industry has barely been able to keep pace with demand, and is still grappling with the task of maintaining and increasing the margin of reserve capacity which is needed for national security.

"The problem of financing capital expenditures is a serious one. In 1951, for example, in addition to the funds available from depreciation and depletion reserves, plus the balance of earnings after dividend payments, it was necessary to draw upon our cash reserves. This latter source of capital is obviously limited, and depreciation and depletion reserves can be expected to supply relatively small additional funds each year. Most of the burden of capital expenditures must fall on retained earnings."

After stating that large outlays for exploration and development of oil fields and for manufacturing, distribution, and other facilities are vital for continued success of the company, Standard Oil of California adds:

"It follows that current earnings are necessarily carrying a larger share of the various replacement costs than has been the case in the past. Depreciation and depletion charges against earnings are based upon historic costs without regard for the decline in the purchasing power of the dollar and are not sufficient to cover replacements. Most oil production profits today, for instance, are from sale of oil discovered at relatively lower costs some years ago."

Over a period of years, Continental Oil Company's capital amortization charges against earnings, consisting of intangible development costs, surrendered leases, depletion, depreciation, and retirements, have been insufficient to cover capital expenditures. The disparity has to be met to an increasing extent out of net earnings.

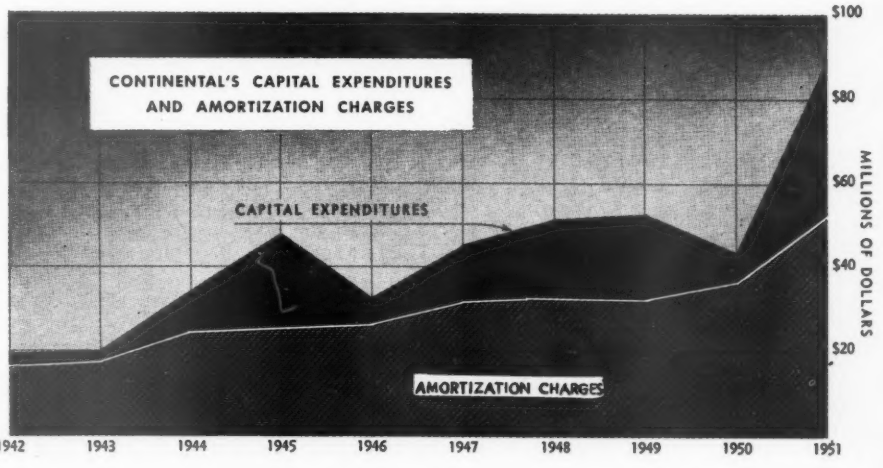
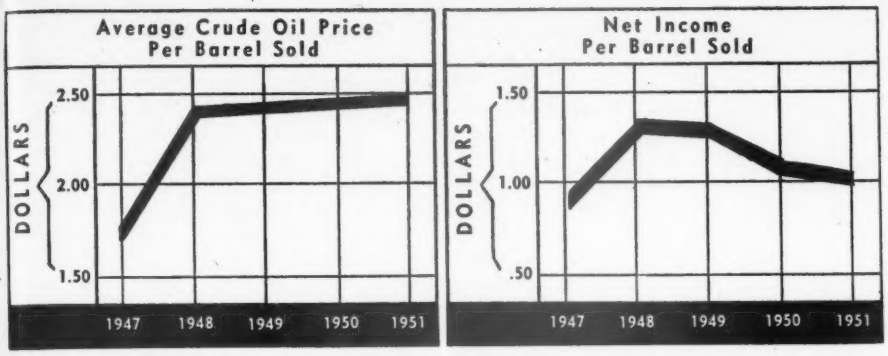


TABLE 2. FINANCIAL STATISTICS FOR 1951 GIVEN IN COMPANY ANNUAL REPORTS.

Company	Gross inc. before taxes 1951, $1000	Per cent of 1950	Gross inc. first quar. 1952, $1000	Per cent of 1951	Net inc. after taxes 1951, $1000	Per cent of 1950	Direct taxes, $1000	Per cent of net income	Taxes collected for govts., $1000	Common stock 1000 shares	Net inc. per share	Taxes per share	Div. per share	Average number employees	Payroll and benefits, $1000	Net cap. (fixed) assets, $1000 Dec. 31, 51	Current assets $1000 Dec. 31, 51	Current liabilities $1000 Dec. 31, 51	Ratio current assets to liabilities	Cap. exp. 1951, $1000	Cap. exp. 1952, est. $1000
Amerada	71,212	120			16,297					3,155	5.17		3.00			48,084	35,474	8,390	4.2	33,925	
American Republics	21,039	116			4,754	98	1,287	27		1,500	3.17	.69	1.50			18,863	13,213	3,284	4.0	6,245	
Anderson-Prichard	34,300	111	8,500	113	4,850	103	715	15	687	813	5.96	1.72	1.80	510	2,650	26,500	8,450	4,380	2.0	8,200	8,000
Argo oil	7,453	109			3,535	124	810	23		2,000	1.77	.41	† .72			10,720	4,655	1,131	4.1	869	
Ashland Oil and Refining	205,996	142	59,871	118	12,138	121			18,835	2,197	5.11	4.41	2.00	4,200		56,814	66,622	29,346	2.3	22,594	
Atlantic Refining	564,300	117	152,330	107	45,067	110	36,065	80	52,585	3,585	12.20	10.06	4.00	20,000	85,896	315,965	148,271	76,722	1.9	71,327	83,000
Bishop Oil	1,862	123	417	93	408	148				360	1.13		† .20	127		2,638	860	514	1.6	577	600
British-American	30,042	119			13,099	125	17,917	132	31,500	7,618	1.72	2.35	50	5,000	18,510	168,165	63,432	31,852	2.0	33,219	
Cities Service	835,565	119			57,178	101	50,744	89		3,889	14.71	1.30	5.00	14,000		620,628	321,358	119,422	2.7	82,000	
Continental Oil	382,168	108	94,503	112	41,293	97	26,462	64	40,920	9,717	4.25	2.72	2.50	8,280	38,400	263,700	98,486	47,568	2.0	88,748	96,900
Cosden Petroleum Corporation[5]	31,008	141			2,088		1,956	70		675	3.09	4.23	.95	450		6,596	6,596	4,206	1.6	1,699	6,000
Creole Petroleum	604,644	117			202,278	121	99,124	49		25,865	7.82	3.83	5.75	‡14,500	106,361	473,058	319,958	147,138	2.2	54,816	
Deep Rock Oil	45,418	120	10,914	89	2,241	75	1,351	60	3,646	449	4.99	3.00	2.00	1,130	5,650	22,426	15,336	5,524	2.8	4,445	6,380
Derby Oil	16,858	109	3,231	83	1,466	134	746	51		443	3.31	1.00	91	380	1,494	9,899	4,502	2,901	1.6		
General American Oil[5]	10,394	132			4,477	138				1,000	4.42			275	1,271	75,821	6,385	1,790	3.6	5,309	
Gulf Oil	1,439,373	125			140,071	126	134,055	96	192,021	22,691	6.17	5.91	2.00	‡46,800	183,000	992,078	601,294	275,570	2.2	176,287	
Hancock Oil	58,830	125	14,594	103	3,010	94	2,440	78	7,727	2,935	1.03	.79	.40	300		1,890	21,423	4,405	4.8	1,077	1,800
Houston Oil	25,514	118	7,143	111	7,054	116	3,137	44	757	1,099	6.42	2.86	2.50	717	3,198	54,500	13,325	6,642	2.0	12,040	12,036
Honolulu Oil	25,189	114			7,927	118	4,196	53		1,875	4.23	2.24	2.50	‡445		53,363	18,652	4,332	4.3	8,800	
Humble Oil and Refining	951,051	120			169,481	131	84,850	50		35,878	4.72	2.36	2.25	‡18,112	106,019	770,577	282,650	139,334	2.0	158,794	
Imperial Oil	594,787	117			35,951	118	50,674	141		29,847	1.20	1.70	.65		6,000	503,269	272,875	55,266	4.9	57,209	
Lion Oil	86,467	105	23,629	106	11,751	84	8,803	75		2,619	4.37	3.27	2.00	2,445	11,421	72,019	35,097	9,580	3.7	16,299	
Mid-Continent Petroleum	157,597	115	41,456	113	17,062	109	27,719	162	12,848	1,858	9.18	14.92	3.75			81,716	86,182	28,566	3.7	15,287	
Ohio Oil	209,385	109	54,700	109	41,681	111	23,078	55	11,995	6,563	6.35	3.52	3.00	5,917	31,797	233,997	95,984	30,910	3.1	38,117	40,000
Pacific Western Oil	8,329[6]	121			7,805	133				4,534	1.60		Stk.			23,324	22,854	15,203	1.5		
Pan-Am. Pet. and Trans.	413,100	128			24,286	119	33,821	139	56,917	4,703	5.14	7.19	1.75	7,900	36,983	154,848	115,267	94,321	1.2	21,350	
Panhandle Prod. and Refining	12,391	104	3,013	96	1,352	104	791	59	2,050	1,593	.85	.50	.27	305	1,275	12,255	4,279	2,859	1.5	840	1,000
Phillips Petroleum	610,771	114	170,440	121	73,711	143	36,180	49	90,000	13,534	5.45	2.67	2.30	‡ 20,618	100,679	672,300	193,458	107,340	1.8	160,180	170,000
Plymouth Oil	98,967	135			10,296	121	6,333	62		2,432	4.24	2.60	1.30			40,765	29,165	15,381	1.9	8,714	
Pure Oil	329,180	110			33,594	111	30,453	90		3,982	7.88	7.65	2.50	10,000			107,962	27,499	3.9	31,000	
Quaker State Oil Refining	52,118	110			2,148	70	3,246	151	5,246	927	2.32	3.50	2.00	2,030	7,054	11,698	17,544	5,828	3.0	3,573	
Richfield Oil	186,461	120	44,435	101	28,218	122	32,710	116	28,302	4,000	7.05	8.18	3.50	4,592	23,439	119,596	76,213	14,528	5.2		
Seaboard Oil	34,008	121	8,581	104	6,425	105	2,900	45		1,244	5.26	2.38	2.75			22,175	17,598	6,818	2.6		
Shamrock Oil and Gas	29,703	106			5,204	109	2,647	43		1,346	3.86		1.90	654		28,603	8,098	4,953	1.6	5,746	
Shell Oil	1,072,434	117	289,150	111	97,020	103	140,885	107	150,230	13,471	7.20	10.46	3.00	31,319	175,176	429,613		114,115	2.8	145,714	
Signal Oil and Gas					8,549	114	3,440	40			7.93		1.50	‡568	3,451	31,107	33,095	8,005	4.1	5,846	
Sinclair Oil Corporation	808,982	119	220,754	109	81,898	117	55,905	68	131,000	12,078	6.78	4.63	2.00	22,112	101,583	879,957	610,378	261,725	2.3	176,197	
Skelly Oil	197,139	113	49,415	104	31,075	108	10,695	30	17,030	2,612	11.89	4.09	3.25	4,590	19,363	176,082	56,060	27,637	2.0	43,251	
Socony-Vacuum	1,584,045	113	396,911	108	161,622	126	125,366	77	192,749	31,802	5.08	3.94	1.80	*43,000	*255,387	880,791	610,378	261,725	2.3	176,197	250,000
South Penn Oil	58,082	106	41,000	111	8,734	115	7,858	90	5,030	1,722	5.07	4.56	3.50	12,583	10,060	21,518	30,020	10,391	2.9	5,031	5,349
Standard Oil of California	1,042,066	120	261,176	109	173,341	115	126,252	73	116,639	28,673	6.05	4.40	2.60	31,633	161,108	903,493	409,660	177,193	2.3	143,451	[4]250,000
Standard of Indiana	1,559,000	118			148,700	120	130,435	88	205,883	15,320	9.71	8.51	3.94	‡49,740	255,880	1,272,000	559,750	236,260	2.4	183,100	
Standard of New Jersey	[3]3,863,317	121[4]			[2]528,461	129	400,700	76	329,900	60,571	8.72	6.62	4.12	120,000	600,500	2,272,916	1,892,029	685,515	2.8	381,824	
Sun Oil	576,340	116			45,354	125	38,454	85	85,207	6,636	6.85	5.86	1.00	20,267	98,192	219,919	151,834	58,472	2.6	80,000	110,000
Sunray Oil	126,355	135	31,513	105	24,283	119	17,851	74		9,970	2.23	1.79	1.20	2,219	10,669	221,819	48,432	16,057	3.0	36,048	42,500
Superior Oil	73,129	121	17,257	111	13,296	192	6,369	48		423	31.43	1.51	4.00	2,481		78,118	27,885	11,454	2.4	40,635	
Texas Company	1,490,077	114	42,593	105	178,775	120	121,500	68	218,291	27,595	6.50	4.42	3.05	39,747	191,208	1,549,421	516,723	131,024	3.9	177,042	250,000
Texas Gulf Prod.	10,411	106	2,679	101	3,153	103	1,383	23		1,107	2.85	1.25	1.40	175	968,689	17,892	3,881	1,377	2.8	3,040	3,000
Texas Pacific Coal and Oil	18,563	122	4,882	115	6,824	114	2,467	36		1,772	3.85	1.39	1.65	400		27,924	8,177	1,922	4.3	5,472	
Tide Water Associated	397,290	111	107,078	104	37,061	111	13,349	36	47,263	6,397	5.79	4.23	2.15	11,447	[5]53,261	179,598	132,271	50,538	2.6	32,610	
Union Oil of California	274,885	127	68,138	100	27,296	159	21,733	80	43,730	5,266	5.01	4.13[3]	2.00	8,383	45,342	259,269	85,151	35,049	2.4	62,421	66,600
Universal Consolidated Oil	5,422	99	1,161	77	2,531	111	961	38		292	8.68	3.30	5.00	102	603	31,709	6,314	208	30.3	1,036	1,000
Wilcox Oil	10,274	111	2,918	107	860	122	492	57		281	3.06	1.75	.90	221	869	7,698	3,131	1,853	1.7	1,101	
United Gas Corporation	125,666	118			18,313	109	15,925	87		11,719	1.63	1.36	1.00	‡5,702	22,354	506,886	54,500	33,000	1.7	113,310	

† Plus stock. ‡ Dec. 31, 1951. g Gross. * U. S. only.

[1] Payroll only.
[2] 60 per cent of consolidated net income earned by companies working outside U. S.
[3] If motor fuel, sales, and excise taxes were included, the tax per share would be $12.43 per common share.
[4] This report includes Humble (72%), Creole (94%), and Imperial (70%) as well as 19 other consolidated companies.
[5] Annual report as of June 30, 1951
[6] Oil operations only



Texas Pacific Coal and Oil Company report carried this comparison showing that the average crude oil price has leveled off since the upturn in 1947 but net income per barrel sold is on the down-grade.

Sun Oil Company explains that only approximately $1 out of $7 earned went to stockholders. Then $6 from each stock's earnings was retained for replacement, modernization, and expansion of facilities. "The alternatives," state the report, "would be to permit our plants and facilities to deteriorate, thus permanently impairing our ability to meet our obligations; to borrow the needed funds, thus deferring the problem to a future year by going into debt; or to obtain the sums needed by a new stock offering, thus diluting the equity of the present outstanding shares."

To put it bluntly, what the report says is that the earnings are not profits. If a grocer cannot replace his stock except by dipping into "profits" he can charge the increased costs off in estimating his income tax. The oil and gas companies cannot.

Union Oil of California report says "Our present tax laws provide for depreciation and depletion based on low historical costs. The resulting overstated profits are thus subjected to income tax levies which constitute, in effect, a tax on capital. As a result, the entire petroleum industry is faced with a serious financing problem."

Many companies in 1951 borrowed money. Interest for the sums borrowed were around 3½ per cent, about the same percentage that stockholders were receiving for risk capital. Overall, it might be said that petroleum industry dividends were paid with borrowed money. It is difficult to estimate the amount of loans entered into by the whole industry but it was high despite the many companies able to finance from earnings. With capital expenditures more than net profits the industry's dividend payments had to come from reduced reserves, borrowings, or sale of more shares.

Consolidated companies of Standard Oil of New Jersey have spent $2.353 billion since the close of World War II to replace equipment or expand capacity. This was $1.328 billion greater than depreciation and depletion provisions, the excess being financed largely out of earnings.

States the report of Pan American Petroleum and Transport Company: "Our tools wear out, just as do automobiles. Crude oil reserves are used up, just as the lead in a pencil. Replacement is the cost of doing business, which must be met. The amount cannot be treated as income if we are to maintain intact the capital with which we do business.

"The Federal government recognizes these facts, in principle. However, the amount which it recognizes as a replacement fund is insufficient in these days of increasing costs. Taxes are imposed on the additional amount required for replacement at higher prices—just as if that amount were income, which it is not. The result as aptly been described as a 'hidden erosion of capital'."

Table 1 giving tax deductions and capital expenditures shows that deductions, even including the controversial depletion allowance of 27½ per cent, is only about half the sum spent for replacing and expanding the nation's supply of oil and gas and its products.

In this financial accounting we get a glimpse of the fantasy of figures that inflation and taxation has laid upon the real value of the oil industry.

"FOR SALE" reads a Wall Street Journal advertisement, "All stock in corporation with 1950-51 tax loss carryover of $80,000. No assets." This is a hot item and no doubt was snapped up.

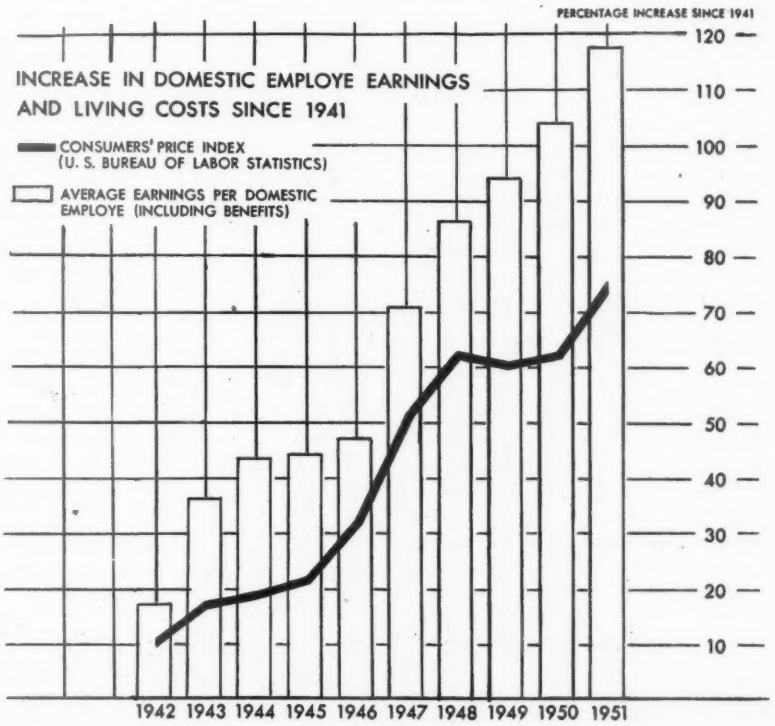
What price progress! The results of abnormal taxation are felt far beyond the dollar cost.

Depletion

In the overall picture given above of tax allowances and the vast sums needed in addition to keep the growing and competitive oil industry in business, the deductions, as we said, includes the depletion allowance, which is called a "loophole" by many who seem bent on taxing the most taxed industry right out of the economic picture. The trouble is that the great majority of the public, including some of their spokesmen, haven't the faintest idea what depletion means. Some persons in the oil industry are in the same situation. It can't be explained easily, as much in this complicated economic system of ours can't be readily explained. One comparison that is somewhat surrealist but essentially accurate is this:

Suppose you are a grocer ordering stock for your store from a wholesaler. You send an order and money to cover it. This wholesaler always keeps the

The Texas Company showed the relation of wages and living costs in the United States. Several company reports indicated employee earnings and benefits had risen rapidly. Taxes rose even more. Total taxes arising from Texaco operations exceeded payments to employees and stockholders by $64,700,000 in the year 1951.



money but he only returns groceries about one out of nine orders and even then not as much as you ordered.

Suppose there was no recourse against the wholesaler—you have to deal with him alone and you can't sue for your money.

Under those conditions only a madman would stay in the grocery business.

Then suppose Congress decided that on the groceries you did get, the U. S. Treasury would allow you 27½ per cent off your tax assessment, if it did not exceed 50 per cent of the net income. If you felt lucky you might stay in the grocery business.

The oil producer has Mother Nature as his wholesaler and no action by Congress, the President, or decision of the Supreme Court can make this wholesaler return oil reserves for the funds spent on exploring, drilling, and producing. Congress gives the oil operator a tax allowance of 27½ per cent on the oil he uses up so he'll have enough money left to keep on ordering oil reserves.

When the 27½ per cent depletion allowance went into effect in 1926 we had 8.8 billion barrels in oil reserves. Since then we have produced more than 30 billion barrels and still have 32 billion barrels left in proved reserves, so the tax allowance has been successful in keeping our stores of oil and gas well stocked.

The Houston Oil Company of Texas report explains it this way:

"The year 1951 witnessed another concerted attack on the depletion allowances which Congress has so wisely used as an incentive to the oil industry to increase domestic reserves. The attack was unsuccessful but there is every indication that its proponents will continue the assault at their every opportunity.

"The industry is intensifying its efforts to acquaint the public with how necessary the depletion allowance is for the maintenance of an adequate fuel supply at reasonable prices. Stockholders and employees are encouraged to assist in this educational program by pointing out that the benefits of the depletion allowance have been passed on to the public through lower prices for gasoline, fuel oil and other petroleum products and that any reduction in the allowance is sure to cause the price of these essential commodities to increase."

The Luxury Items

"The myriad uses to which products from petroleum and natural gas are put today make it impossible to conceive of our economy without this basic industry. Even in the post-war years through 1951 total petroleum demand in this country has increased by nearly 50 per cent. Some of the causes of this growth have been a 300 per cent increase in requirements for aviation gasoline, a 70 per cent increase in the number of automotive vehicles, an 80 per cent increase in farm tractors, a 125 per cent increase in central oil heating installations, and a 350 per cent increase in diesel locomotives. Volume sales of all gas utilities stepped up 90 per cent in the 1946-51 period, and the production of chemicals derived from petroleum and natural gas increased many fold."

Thus begins a study of Phillips Oil Company by a security investment company.

Yet the products of this basic industry are taxed as if they were great luxuries.

Socony-Vacuum Oil Company puts it this way:

"For the first three and a half months of this year all our earnings went to the Federal Government, for the next month and a half they went to state and local governments, and the year was about half gone before we could begin storing up anything for the benefit of the stockholders. We collected for the Federal, various state and local governments $191,500,000 in excise taxes on gasoline and lubricants. In addition, the Federal Government was enabled to tax again a large part of the company's earnings by taxing your dividends." (After dividends are paid to a stockholder they are subjected to tax assessment as personal income).

Says the Lion Oil Company's report: "State and Federal taxes added $2.4 billion to the nation's gasoline bill last year and this burden will be greater in 1952. Gasoline — already the most heavily taxed non-luxury product—was subjected to an increase in taxation on November 1, 1951, when the Federal gasoline tax (first enacted in 1932 as a temporary measure) was increased to 2 cents from the previous 1½ cent rate."

No one thinks of gasoline as a luxury in our economy but gasoline is the only product—except tobacco and liquor—that costs less than the taxes assessed against it. *Newsweek*, in an analysis of tax assessments, estimated the average cost of gasoline at 12 cents a gallon, the

TABLE 3. Operations in 1951.

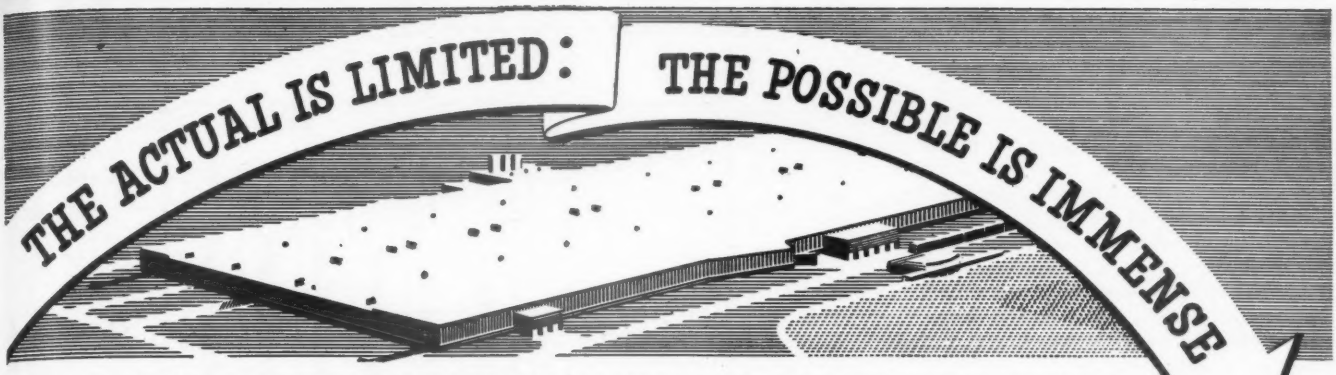
Company	Net acreage, lease or fee developed or undev.	number wells[1] drilled 1951	Wildcats	Dry holes 1951	Prod. wells in 1951	Total prod. wells owned	Daily average prod. net bbl 1951	Daily average gas prod. MCF	Daily average refinery runs 1951, bbl
Amerada	7,664,000	g251		g75	g176	2,221	63,758		
American Republics	952,889	124	28	28	96	270	10,910	37,978	
Anderson-Prichard	225,000	114	25	33	81	650	11,023		9,638
Argo Oil	343,911	56		21	35		8,905		
Ashland Oil and Ref.	397,542	139		57	82	2,739	7,734	6,046	93,724
Atlantic Refining	4,904,000	328		77	251	3,343	97,124		173,538
Bishop Oil	62,056	12		5	7	299	2,487	144	
British-American	4,180,000						18,852		63,345
Cities Service	10,309,000	470	63	82	388		120,555	663,315	206,895
Continental Oil	17,956,250	534	124	161	373		118,410	348,219	102,123
Creole Petroleum	3,187,871	239		15	224	2652	758,025		126,799
Cosden Petroleum Corp.[5]		14		3	11		1,582		18,238
Deep Rock Oil	877,800	123	g41	39	84	1,261	8,141	9,184	16,800
Derby Oil	133,714	75		24		522	3,332		9,095
General American Oil[5]						744	10,451		
Gulf Oil	12,509,000	1,100	144				633,337	589,000	500,951
Hancock Oil	1,101,893	63		5	58	247	13,900	9,275	12,119
Houston Oil	1,313,000	70	26	16	54	g747	13,956	64,288	
Honolulu Oil	1,655,904	g77		g24	g43	g1,771	29,900	45,766	
Humble Oil and Refining	[6]15,879,098	1,133	148	240	893	10,866	374,112		246,700
Imperial Oil	g25,000,000	[3]292		12	280	1,074	g62,500	13,000	184,523
Lion Oil	1,418,036	192		41	151	796	19,215		22,660
Mid-Continent Petroleum	1,466,494	199	39	37	142	2,109	19,120		52,395
Ohio Oil	3,060,769	458		83	375	6,935	92,616	147,943	36,430
Pacific Western Oil	475,900	24		5	19	507	9,420		
Pan-Am. Pet. and Trans.			20		49	689	22,148		137,564
Panhandle Prod. and Ref.	50,000	22	4	9	13	430	4,118	16,662	5,000
Phillips Petroleum	9,224,917	*g639	*40	g73	*g510	*g11,687	118,566	[3]1,587,000	187,000
Plymouth Oil	467,747	92		21	71	931	19,419		37,315
Pure Oil	3,303,000					6,163	73,693		118,860
Quaker State Oil Refining					49		2,722		8,865
Richfield Oil	171,966	94				1,086	58,633		101,756
Seaboard Oil		134		51	83		31,000		
Shamrock Oil and Gas	457,200	63	4	4	59		11,914	221,909	9,051
Shell Oil	16,829,626	573		92	481	7,373	236,000	628,500	389,000
Signal Oil and Gas	1,120,000	72				688	44,178		
Sinclair Oil Corp.	10,097,815	671	74	117	554		117,489		371,055
Skelly Oil	3,965,072	379		81	298	3,588	63,745	-283,050	42,430
Socony-Vacuum[2]	10,773,224	*784		*110	*674	*12,737	379,121	*831,000	620,000
South Penn Oil	688,596	189		3	186	12,483	11,438	[2]9,696,796	8,460
Standard Oil of California	19,673,148	563		103	460	6,907	328,107	406,799	379,494
Standard of Indiana	14,993,400	529		157	372	9,043	260,270	669,000	514,100
Standard of New Jersey[4]							1,455,000		1,807,000
Sun Oil Co.	9,000,000	600	182	189	411		111,665		205,192
Sunray Oil	3,295,585	261		57	204	3,330	72,966	153,425	37,138
Superior Oil		211		61	150		57,040	120,548	
Texas Company	107,407,816	*1,106	294				318,164		490,263
Texas Gulf Prod.	1,190,828	42		14	28	333	9,598	28,230	
Texas Pacific Coal and Oil	940,071	111		27	81	1,184	18,752		
Tide Water Associated	1,628,295	187		24	163	5,566	102,953	158,912	167,989
Union Oil of California		272		106	166		93,899		129,608
Universal Consolidated Oil	29,000	14		8	6	249	6,219	7,367	
Wilcox Oil	78,630	28	12	13	15	310	2,498		4,187
United Gas Corp.		89	13	17	72	1,300	17,099	[3]1,890,041	

‡ Plus stock. g Gross. ‡ Dec. 3, 1951. * U. S. only.

[1] Water intake wells not included. [2] Gas sales. [3] Development wells only.

[4] This report includes Humble (72%), Creole (94%) and Imperial (70%) owned by Jersey Standard as well as 19 other consolidated companies.

[5] Annual report as of June 30, 1951. [6] 1950 Acreage.



NEW LINCOLN PLANT CREATED BY INCENTIVE-INSPIRED CO-ACTION IN DEVELOPING POSSIBILITIES IN PRODUCT

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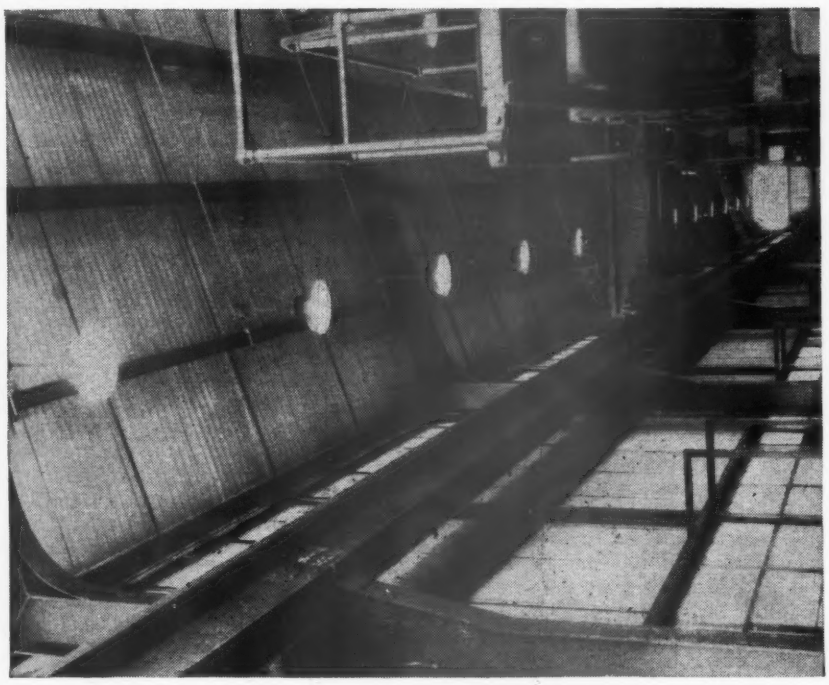


CONSTRUCTS COMPRESSOR STATION WITH ARC WELDING

THE building for this compressor station is of rigid frame design, fabricated by arc welding. Its interior is clean, easy to light and simple to maintain.

Columns and roof members were shop fabricated at low cost from standard "I" beams using fast, downhand welding techniques. Structural members were then erected, guyed and field welded in 5 days.

Fig. 3 Detail Construction *of compressor station for underground storage. Oakford Station, New York State Natural Gas Corporation. Building Contractors, Fabricators and Erectors: Pittsburgh Bridge and Iron Works. Pipe Fabricators: Dravo Construction Co., Pittsburgh, Pa.*

SPEEDS WELDING

Fig. 1 Fabricated Fittings *from pipe and welding tees. Joints are bevelled 60° and welded with 3 passes of Lincoln "Fleetweld 5" using "Shield-Arc" engine-driven arc welders. Connections pressure tested to withstand 1250 psi are found free of leaks.*

Fig. 2 Builds Cloverleaf *from half sections of 18" pipe six feet long. Assembly is shop welded and placed in position to protect outside valve units. Sturdy covers are made at low cost from steel plate.*

SIMPLIFIES INSTALLATION

Bulletin 462 on Mild Steel Electrodes free on request. Write to Dept. 184,

THE LINCOLN ELECTRIC COMPANY

CLEVELAND 17, OHIO

The World's Largest Manufacturer of Arc Welding Equipment

direct and indirect taxes at 14 cents a gallon.

This is a situation which causes the public to listen receptively to the harrangues against the "rich oil companies". A man who fills the tank in his jalopy does not know that the local, state, and federal governments get more of what he paid for his car's fuel than the wildcatter who went out to find the crude oil and the pipeliners who moved it and the refinery that processed it and the distributor who sold it to the filling station and the owner of the filling station who serviced his car.

It is time he found out. The Federal government, which spent $3.5 billion in 1951 to explain and promote the federal bureaus, are not going to tell him so it falls upon the oil industry itself to get the facts to the public.

The Stockholder

Total number of stockholders is growing and the small stockholder is increasing by leaps and bounds. Jersey Standard had an overall increase of 54 per cent in shareholders from 1946 to 1951 and the number who owned from 1 to 20 shares rose 217 per cent.

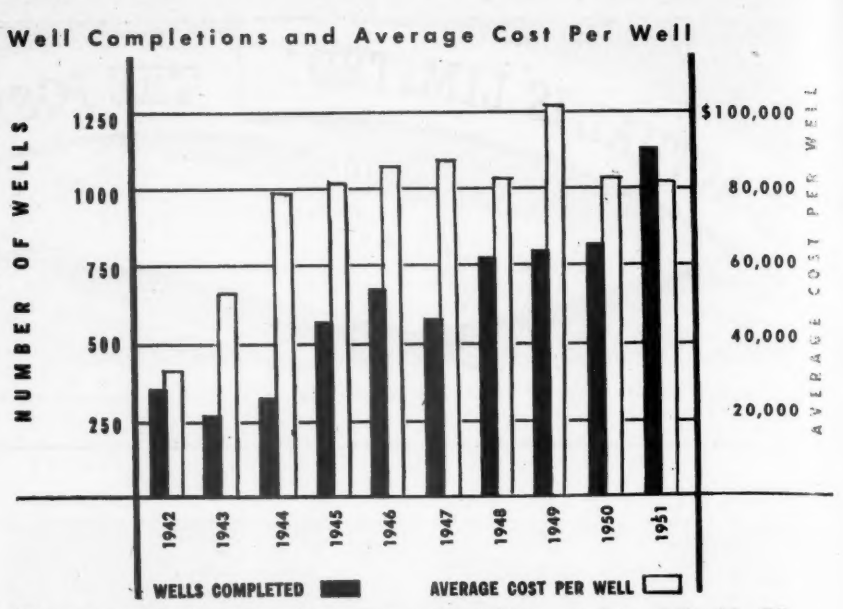
To many of these new stockholders annual reports are less than illuminating. They are not going to dig into obsolete bookkeeping to figure out why earnings and loans must be used to finance a company that is supposed to be heavily capitalized.

It is more important than ever to make financial reports clear and simple so that shareholders inexperienced in the complex operations of modern industry can interpret correctly the function of capital. It is to the advantage of the company and the industry to have stockholders understand the problems, both financial and operational, that arise.

TABLE 4. Reserves.

Company	Oil and/or LPG 1000 bbl	Gas 1,000,000 cu ft
Amerada	525,000†	
Anderson-Prichard	45,000†	
Ashland Oil & Ref.	14,000	14,344
Atlantic Refining	495,000	2,180,000
British-American	85,000	116,000
Cities Service		14,100,000
Continental Oil	560,000†	
Cosden Petroleum	12,619	
Creole Petroleum	4,100,000†	
General American	61,140	17,550
Gulf Oil	6,851,000†	
Honolulu Oil	163,500†	285,900
Humble	3,000,000†	
Imperial Oil	735,000†	
Lion Oil	36,400†	100,000
Mid-Continent	175,000†	
Ohio Oil	600,000†	
Panhandle Prod.	5,000†	
Phillips	1,252,560†	15,220,000
Plymouth	250,000†	
Pure Oil	500,000†	
Richfield	385,000	
Seaboard	180,000†	
Shell Oil	1,000,000	
Sinclair	740,000	
Skelly Oil	230,000†	1,053
Socony-Vacuum	4,508,000	7,400,000
South Penn	46,446	86,000
Sun Oil	743,000	
Sunray	350,000†	734,500
Standard of California	1,500,000†	
Standard of Indiana	1,300,000†	
Texas Company	1,852,000	9,600,000
Texas Gulf Prod.	45,000	270,000
Texas Pacific Coal & Oil	85,000†	
Tide Water Associated	529,232	2,000,000
Union of California	481,300	
United Gas	57,488	15,175,000

† Based on investment company estimates.



Drilling more wells than any other company the drilling cost data of Humble Oil and Refining Company is of interest to the whole industry. This graph of completions and average cost is in the Humble report. Dry hole costs for 1951 were 9 times as much as the annual average dry hole costs from 1937-1940.

The Employee

Oil and gas industry employees have made large gains in wages and benefits in the last 20 years. Annual reports show a trend toward larger benefits, such as savings plans, stock buying programs, pensions, etc.

Employee relations are good but here again oil companies need to explain how the so-called profits from industry operations are not lying in the bank idle but are being used to buy more equipment and hire more workers.

Capital investment per employee is perhaps higher in the oil industry than in any other. It costs an average of about $32,000 in equipment to put one worker on the job in the petroleum industry while industry as a whole invests only $7,000 for each worker.

Galloping Gains

It is a relief to turn from the debatable facts of financial reports and look at the real gains in operation. States the Plymouth Oil Company report:

"The unparalleled performance of the oil industry in 1951, when new peaks were reached in production, new discoveries, reserves, and number of wells drilled, had the wholesome effect of quieting any apprehensions that America might be without sufficient reserves of petroleum to meet any assault by an aggressor nation. The problem now is to build a surplus productive capacity capable of making those reserves immediately available for military purposes in the event of a sudden national emergency.

"Despite the record consumption of oil in 1951, which reached the stupendous total of 2,481,373,000 bbl—an increase of 310,000,000 bbl over 1950—the industry found or developed 2 new barrels of oil for every one produced during the year. New production discovered or developed in 1951 totaled more than 5 billion barrels."

"Since 1945, the industry has spent approximately $15 billion to provide additional crude oil, refining capacity, transportation facilities, and other collateral equipment," reports the Pure Oil Company. "Since 1946, liquid hydrocarbon reserves increased from 24 billion barrels to approximately 31 billion barrels; gas reserves increased from 160 trillion cubic feet to 191 trillion cubic feet. During the postwar period, refining capacity has increased 1,900,000 bbl per day, and an additional 49,000 miles of crude and product pipe lines have been constructed. Industry and automotive demand for products has increased proportionately. Twenty million more motor vehicles are now on the road. The industry has accomplished this in the face of shortages of material and at constantly increasing levels of cost."

Summary

Study of the annual reports contain more of interest than can be covered in this space. Briefly the highlights reveal:

1. Taxation at present high levels endangers development of the petroleum industry.

2. Tax deductions to compensate for replacement and expansion of equipment and petroleum reserves are unrealistic. The Certificates of Necessity granted certain plants by government agencies should be available for all equipment that becomes obsolete as quickly as does that in the oil and gas industry.

3. Employees and shareholders should be given a better understanding of the real value of "profits" and why they must be used to maintain a company's competitive position in the industry. *

The Oil Industry Is Always in Need of Technical Men With Management Qualities†

FRANK M. PORTER

A PETROLEUM engineering-management conference such as the one held here is a good thing, particularly for students who will soon go into technical jobs. It is an opportunity to meet with men of industry and talk over the problems that industry is facing. It gives an insight into the actual workings of business and how technical men will fit into the picture. In so doing, it paves the way and makes it easier to step from full-time student to full-time practicing technician. Thus it benefits not only individuals, but future employers as well.

The technical man's place in industry and his relation to management is under consideration here, a fitting thing, for we are living today in a technical man's world. The technical man's contributions in the last half century have given him so much stature and so much influence over our daily lives that it would be hard to imagine a world without him. Indeed, most of us cannot now remember the time when we were not utilizing the fruits of his harvest.

In 1900, basic science was well established. The internal combustion engine, the telephone, the electric light, the principles of aerodynamics, and countless other things had been conceived and developed, but the world had not begun to understand and appreciate their potential usefulness. Oil had been discovered more than 40 years before, but no one even dreamed that it would one day supply over half the energy used in this great nation. Atomic energy was more a figment of the imagination then than space travel is today.

Gradually, the world began to realize how these tools the technical man had given it could be used to make life easier and more profitable. Instead of often being considered a thing apart and, even at times, an idealistic dreamer, the technical man began to be looked on with respect and admiration. He was accepted as an integral part of industry, and he was encouraged to pursue his studies into the realm of the unknown. He began to learn more about nature's secrets, and how to harness them for the benefit of the world. He even learned how to rival nature by developing synthetics of better quality that could be produced in greater abundance and at a lower cost than nature's own products.

What has all this meant to the world? In some countries, it is true, it has meant only increased power for dictators—power they have used solely to carry out their own selfish ends. In our own country, it has meant the highest standard of living in the world. It has meant increased production that has made available, even to people of moderate means, goods and services that are considered impossible luxuries in most areas. So abundant has been the output of the technical man that we have come to take it for granted, and we no longer marvel at his ability to conquer seemingly impossible problems. Indeed, we have come to look upon the technical man as the solution to all our problems, and there is virtually no phase of our life—economic, social, or governmental—that is not influenced by him.

Essentially, all this has come about in the 50-odd years since 1900. It is no wonder, then, that this period has been called the most significant half-century in the history of civilization. And who can doubt it? What other comparable period has contributed so much to the progress of mankind?

It has been this same half-century that has seen our own nation move to the fore as a leader among the world's powers. I have no doubt that this occurred largely because of the efforts of our technically-trained people. Not necessarily because they were better-trained; other nations have had well-trained scientists, too, but have failed to accomplish as much. Witness the Germans, for example. The difference lies, I believe, in the fact that American scientists have been free to pursue their ideas without fear of persecution by the State, and with the promise of a just reward for their efforts. They are free to follow the spirit that Rudyard Kipling portrayed in his poem "The Pioneer"—"Something lost behind the ranges; go and find it..." The technical man is the modern pioneer. He finds the new continents, clears the new lands and leaves them for others to develop, while he moves on to new and greater achievements. His eye is always on the far horizon, searching for something bigger and better and more useful. His most satisfying reward comes from the search and the discovery, and the knowledge that others benefit from his ideas. The pioneering spirit, the freedom to carry on his search in the way he thinks best, and the promise of reward that our free enterprise system carries with it—these are the things that make our scientists and technical men superior to the rest of the world's; these are the things that have enabled them to help carry our nation to the position it now occupies. "Science and technology can flourish only in a society in which there are intellectual freedom and freedom of expression. Our competitive economy not only provides these conditions, but it stimulates the best efforts of thousands of individuals to pursue independent paths of inquiry unhampered by centralized control."

Management has played its part in this cause, too. It is management's place to adopt the technologists' ideas and to

The Author

Frank M. Porter is president of the American Petroleum Institute and also heads Fain-Porter Drilling Company, Oklahoma City.

His first association with the oil industry was in 1916 with Dundee Petroleum Company, and two years later he worked with Wirt Franklin, independent operator. When the Wirt Franklin Petroleum Corporation was formed he became vice president in charge of oil-production operations. In 1939 together with the late Leslie Fain of Oklahoma City, he formed the Fain-Porter Drilling Company, becoming sole owner upon Fain's death in 1944.

Porter, who was named the 10th president of API in April of 1950, was elected president of Kansas-Oklahoma Division, Mid-Continent Oil and Gas Association, in 1943. He served three terms in this office and was acting president of the general Mid-Continent Association from 1945 until early 1946 when he was elected president. He resigned from this office in 1950.

†Presented before the Petroleum Engineering-Management Conference, The University of Oklahoma, Norman, Oklahoma, March 14, 1952.

see that they are developed to the greatest benefit of mankind. Here again, freedom, the promise of a just reward, and that typically American competitive attitude—the desire to do something better than the next fellow—have combined to give our industrial machine a long lead in the race for supremacy.

Some industries, it is true, have not done all they could with the ideas presented to them. They have been content merely to harvest the crops from the fields the technologists discovered for them. They have contributed little or nothing in return. But these are the industries that soon reach a static point; a point where they no longer continue to progress and expand, but instead begin to falter and fall back. Fortunately, these are few and far between.

The oil industry is not one to which that indictment can be applied. To me, the oil industry typifies the spirit of progress that Kipling described. The very fact that the oil industry spends more than $100,000,000 every year on research is indicative of its willingness to pioneer. It has been quick to recognize and use the questing spirit of the technical man and, as a direct result, it has accomplished a great many things that the skeptics thought impossible.

Take, for example, our reserves of oil. For decades we have heard dire predictions that this nation was running out of oil. In 1925, it was estimated that we had only 8½ billion barrels of proved recoverable reserves, and the alarmists were saying that our supply would last only a few years. Since that time, we have produced nearly 35 billion barrels of crude oil. And our proved reserves as of the first of this year are estimated at more than 32 billion barrels—or nearly four times as much as we "had" in 1925.

The knowledge and skill of the technical man have made this possible. He developed new ways of seeking out potential oil-bearing structures, and new equipment capable of drilling to far greater depths. He figured out ways to produce oil from deep wells, and he learned how to supplement the natural energy in a reservoir so as to recover an ever-increasing amount of the oil in place. The job is not yet finished; the challenge is still there. We are confident there are many more billions of barrels of oil to be found, and we are hopeful that our technicians will find ways to recover more and more oil from each reservoir—to the end that we will vastly improve our current average of 35 to 40 per cent recovery of the oil in place.

Scientists and technical men have been a part of the oil scene for many years. History records that they were first called on about 1890 to solve the problem of how to refine the new sulfur-bearing crudes that had been found about that time in the fields around Lima, Ohio. They were successful in that venture, and they have been an essential part of the industry picture ever since. Today, more than 17,000 people—both technical and non-technical—are employed by the oil industry in research

Conference at O. U.

The University of Oklahoma cast a valuable spotlight on the functions of technicians and industry at its Petroleum Engineering Management Conference at Norman, Oklahoma, March 14-15. Oil and gas industry leaders surveyed the situation and came up with some worthwhile ideas.

In this article Frank M. Porter, API head, lists the qualities that convert an engineer into management material. In the address following this, E. DeGolyer describes the characteristics needed in international management.

alone. Technical men can be found in all branches of the industry, in all kinds of jobs, from junior engineers to presidents and board chairmen. More and more, we are finding technical men in high places in industry. What they have accomplished, they have done on sheer merit and hard work. What is more important to you student engineers, the opportunity to do the same thing is present in even larger measure today, chiefly because so many of the problems with which top management is confronted today require an understanding of technology. In the final analysis, it goes back to my earlier statement that we are living in a technical man's world.

In the light of these excellent prospects for technical men, it is particularly distressing to hear of anyone trying to discourage young men from entering technical fields. Yet that is just what happened not long ago. It was during 1948, when our colleges and technical schools were crowded with a backlog of technical students who had resumed their education after an interruption for war. In one of its bulletins, the Bureau of Labor Statistics of the U. S. Department of Labor made this and several other similar statements in regard to the various fields of engineering: "It is likely that many of the graduates within the next few years will be unable to find jobs in the field, particularly if enrollments continue at the present high levels." This bulletin, along with a wall chart that even more flatly predicted an overproduction of engineers, was widely circulated among educational counselors, and there is no doubt but that it influenced a number of young men away from engineering fields. As a result, there is today a lack of young engineers for industrial work, a serious lack that cannot be made up overnight. It is my understanding that freshman enrollments in engineering are up slightly this year, but it will be several years before the slack is taken up. To my mind, this is typical of what always happens when government tries to assume the role of master planner. That task is far too big for any agency—governmental or business—to assume, whether it be in education, industry, medicine, agriculture, or any other field. You cannot tamper with the normal laws of supply and demand and expect to have continuing prosperity. The problems in any particular field are problems that must be dealt with by experts in that field; people who devote all of their time to studying trends and how various factors affect that field. Government simply cannot assume the burden for the entire economy and expect to keep it a going thing.

Suppose we take a few moments to consider what some of those problems are that management in the oil industry is facing. Let's see what challenges lie ahead for the next generation of technical men.

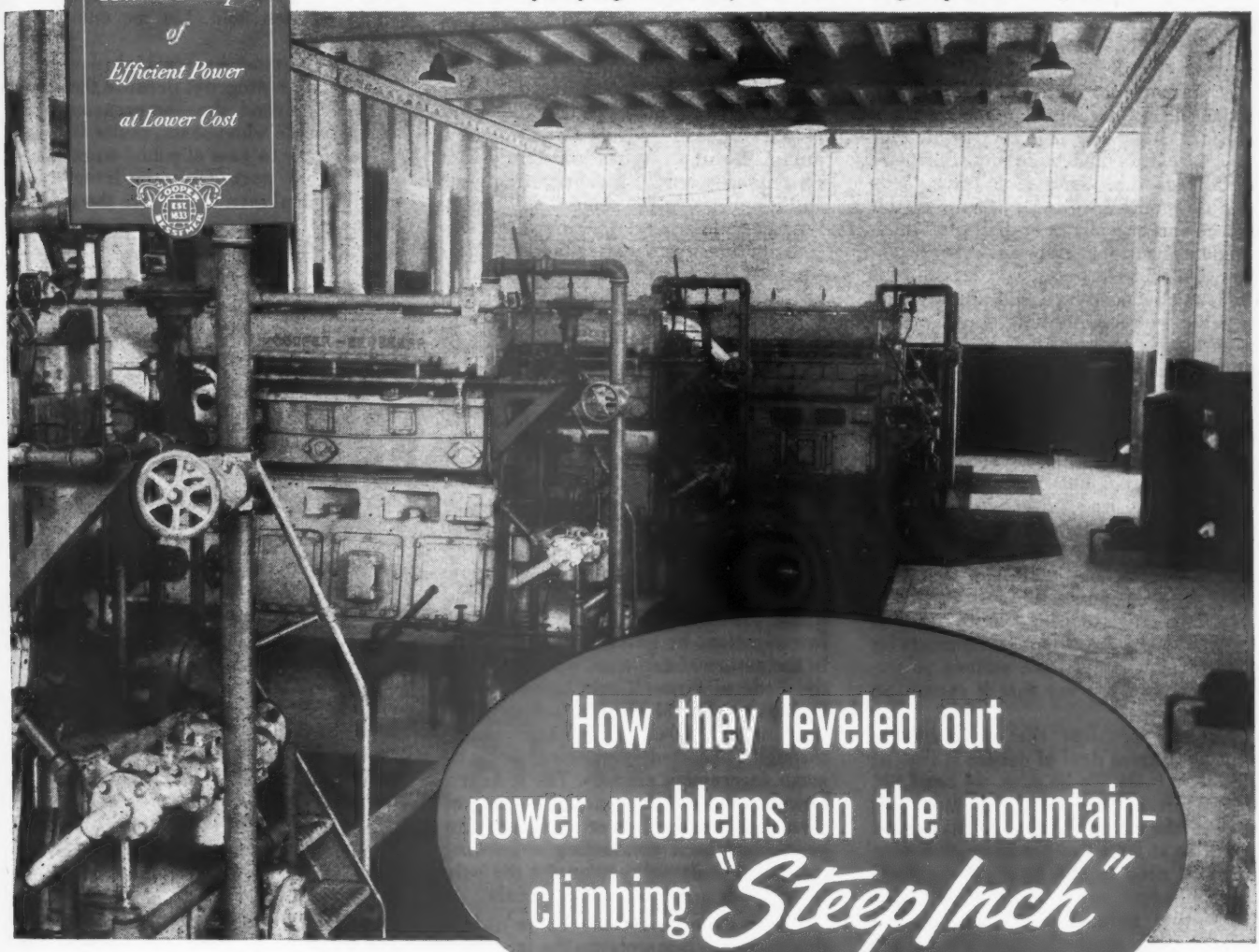
First, of course, is the matter of finding new reserves. A few moments ago, I mentioned the fact that our reserves today are in excess of 32 billion barrels. Higher than ever before, despite the fact that we have in the past 10 years come through a world war and the greatest period of peacetime demand that we have ever known, our reserves have kept increasing faster than our consumption of oil products. To make certain that they continue to do so, we must intensify our exploratory efforts. Demand is still growing, and there is no reason to expect that it will drop off.

Thus, it is incumbent on us in the industry to seek out new ways of finding oil deposits, so that we not only can explore new and hitherto inaccessible territory, but we can also go back over country that has been worked before, and perhaps find formations that we could not earlier detect. A striking example of what I am talking about is found in the great limestone reefs of Scurry County, Texas. This territory had been explored and passed over countless times before a couple of venturesome men spotted it as potentially a great oil field. Their confidence was justified, and Scurry County ranks with the great discoveries of recent years. Undoubtedly there are many more conditions of this kind, and it will be up to our technical men to devise ways of finding them so that their reserves can be recovered.

I also mentioned earlier the problem of increasing the recovery of the oil in place. With the production methods used in the early days in the oil business, we could recover only 10 to 15 per cent of the oil in a pool. Then we learned how to control our production so as to make the most efficient use of the natural reservoir energy. We learned how to supplement the natural energy by injecting gas or water, thereby further increasing our recovery. We learned how to treat formations with acid or by shooting, in order to make the passage of fluids into the well bore easier. All this has helped our recovery picture, and we now get, on an average, from 35 to 40 per cent of the oil in place. In some types of fields, of course, the record is much better, depending on the nature of the formation and the type of drive involved. But the need for improving the overall average persists, and there is a vast opportunity here for technical men with ideas. Some excellent work, of course, is being done today in laboratories all over the oil-

Another Example of Efficient Power at Lower Cost

Three of five Cooper-Bessemer JS-8 diesels, rated 580 hp at 450 rpm, in the Catia de la Mar pumping station of the new Tacagua petroleum products line.



How they leveled out power problems on the mountain-climbing "Steep Inch"

WHAT with grades up to 45 per cent, it's no wonder the Tacagua products line is nicknamed the "Steep Inch." This new line, joint project of Creole Petroleum Corporation and Shell Caribbean Petroleum Company, rises sharply from sea level at Catia de la Mar, reaches a crest of 3,200 feet over mountainous terrain, and terminates at Caracas.

In a project like this, reliable, trouble-free power is more than ever a matter of prime importance. They played safe on this problem — picked Cooper-Bessemer diesels to do the job. The three 580 hp Cooper-Bessemer JS-8's shown above are driving pumps. Two more JS-8's drive generators for electric power requirements. They are the kind of engines you can count on for diesel performance at its best . . . any time, any place, in any service.

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St. Louis, Mo. Los Angeles, Calif. Chicago, Illinois Caracas, Venezuela

producing country, but this is not a problem that will be solved overnight. New blood and new ideas may go a long way toward an ultimate solution.

We need to develop some new thoughts in the field of drilling. Today we have rigs that are capable of going below 20,000 ft, but the rotary method of drilling is a costly one at those depths. Furthermore, it is obvious to any student of mechanics that there is a tremendous loss of energy involved in turning a bit on the end of a string of drill pipe thousands of feet long. Here again is a problem that will not be solved overnight; it will take the combined thinking of many capable people. But it is one to which we are giving a great deal of consideration now, and one that will bear even greater study in the future.

To return for a moment to the field of exploration, you all know that all our modern scientific devices can only point out where oil might be found. We can only prove positively whether it is present by drilling. If someone would develop a fool-proof system for locating oil deposits without drilling, it would be the greatest boon in the industry's history. This may seem far-fetched; but, in the light of all the other achievements by technical men that once seemed so impossible, who can say that it cannot be accomplished?

Another problem that is currently causing a great deal of debate is that of synthetic fuels. To be sure, we need not be concerned immediately about it, and most of the experts in the industry think it will be at least another 25 years before we shall need to look to synthetic fuels to supplement our production of liquid fuels from natural petroleum. At the present time, synthetic fuels simply are not competitive with those resulting from modern refining methods, and a great deal of research must be done on the processes before they will become competitive.

Basically, there are only two ways for a substitute product to enter a market: One, there must be a shortage of the product that it will replace; or, two, the substitute must be produced and sold at a lower cost, and of a quality equal or superior to the original product. We know that there is no shortage of natural petroleum now; nor do we expect demand to outrun supply of petroleum for at least another 25 years. Therefore, it becomes necessary for the proponents of synthetics to develop processes that are competitive in cost, if they wish to enter the liquid fuels market.

Private enterprise has already devoted vast sums of money and manpower to research in this field, so that it will be prepared to move into it as soon as a need develops. Indeed, the technical men of the petroleum industry were studying this problem long before other people began to worry about it. Certainly this is further evidence, if any is needed, of the pioneering instinct of the oil industry.

But perhaps our biggest problem today lies in explaining to the general public what we are doing and why.

The oil industry can look back on a record of magnificent accomplishment. Three decades ago the oil and gas industries provided less than 18 per cent of the energy requirements of the nation, whereas today that figure is in excess of 55 per cent. During that period it has improved its products and made available new ones in advance of every new public demand. It has constantly and continuously reduced its operating costs and its prices, at the same time keeping its wages high and making enormous contributions to federal, state, and local treasuries. It has maintained a research program that is unprecedented in industrial history and makes the results available to its customers for their benefit. It has sought no subsidies, but does its own financing whenever and wherever necessary. We made one dismal mistake, however. We failed to keep the public informed of the industry's status, problems, and aims. We were so busy finding and producing oil and providing high quality products at the lowest possible cost that no time was taken to develop an adequate public relations program. As a result, and to our consternation and dismay, we suffered many unwarranted investigations by governmental agencies in the nature of anti-trust suits, efforts of the Federal Power Commission to gain regulatory control over our industry, and unjustified accusations of tax evasion through purported "loopholes" made by some government officials. The industry, however, has now become fully aware of this problem and, over the past few years, has been conducting a growing campaign designed to acquaint the public with our activities and our goals.

Where does the technical man fit into this picture? Squarely in the middle, I would say, simply because so much of our work involves technical problems. We need technical men who can express themselves simply and in terms which the non-technical person can understand. Most human beings are suspicious of things they cannot understand; likewise they are often opposed to ideas they do not comprehend. A case in point is well spacing. Industry people know that you can, in many cases, drain a pool as efficiently with one well on every 40 acres as you can with one well on every 10 acres. Where this is possible, it is only good business to go to 40-acre spacing. But because many landowners have not had this explained to them in language they can understand, they automatically assume that by drilling only one-fourth as many wells you recover only one-fourth as much oil. And so it is that the industry too often finds itself engaged in costly court proceedings over spacing problems.

Here, then, is where the technical man can make a substantial contribution to the oil industry and its future progress. We cannot succeed—indeed no business can, no matter how large or small—unless we have the backing of the people with whom we must do business. Public opinion can make us or break us.

Besides this quality of being able to speak in clear, concise terms, there are a number of other qualities that a technical man should have if he is to succeed in his chosen field. Let me enumerate them:

First, he must have a high degree of honesty and integrity. Because technical work is beyond the comprehension of many people who use its results, it is relatively easy to pass slipshod work off as satisfactory work. Only the integrity of the technical man can insure the quality of his work.

Second, he must have the ability to work in a team. Nearly all technical and engineering work is the joint effort of several individuals. The "lone wolf" is a hindrance rather than a help to an organization.

Third, he must have vision. He must not get bogged down in insignificant detail and thus lose sight of the larger goal ahead. At the same time, however—and this might be considered a fourth characteristic—he must have a capacity for care and attention to detail, even while he keeps the broad objectives in mind. Many calculations are sensitive to small errors in intermediate steps, and a small error in determining one factor of a study may throw the final result off significantly.

Fifth, he must have initiative. It takes an alert and aggressive man to make a small or routine job grow—to catch all the faults in his phase of the operations and to find ways of eliminating lost motion and inefficiency.

Sixth, he must have tact and consideration for the opinions of others. Not all technical matters are subject to universal agreement. Two or more men may have entirely different ideas about the same technical point—and each may have valid reasons for his opinion. These differences can be resolved by tactful conference and recognition, without damage to the professional standing of opponents.

Seventh, he must have a willingness to learn. Too many technical men feel they have completed their education when they receive a college degree. The technology of the oil industry advances so rapidly that it takes a sustained effort merely to keep abreast of developments, and a further effort to forge ahead.

Finally, the quality that makes the technical man most valuable to management is judgment. Judgment, however, comes from sound training and experience and, generally speaking, only after the technical man has mastered the other seven does he learn to use sound judgment.

The man who exhibits these qualities is quickly recognized in any organization, but the need for him exists in the petroleum industry to a much greater degree than in most. The oil industry already has a great many men of this type, but the market is never saturated. As the industry grows and expands, so does the need for men with special skills and aptitudes. The opportunity to get ahead is there; it is limited only by the individual's ability and his initiative. *

Petroleum Engineering-Management Conference

The Role of the Technician in International Management†

E. DeGOLYER

WHAT is a technician? The answer seems to be "one skilled in a technique." Now the technique may belong to a subject or an art. "The butcher, the baker, the candlestick maker" are technicians. In oil country parlance the driller, the tool dresser, the pumper, the still-man, and the gager are technicians. And the definition of technician can hardly be considered without immediately wondering what the difference if any may be between the technician and the technologist.

To my mind the technologist is concerned with the whole group of techniques in a given field and thus is several cuts above the technician who may be skilled in only a single technique. The technologist is an applied scientist and as such is concerned with the application of scientific knowledge to any practical art. He may even be an inventor of techniques. The metallurgist, the chemist, the petroleum engineer, and the geologist are technologists.

What then is the role of the technician in the management of international oil operations? This depends upon the size of the organization for which the technician works and upon the skill that the technician shows as a manager. If the operation is a big one such as many of the operations in Venezuela and the Middle East and if the technician shows no genius outside the narrow field of his own technique, he is likely to remain a technician abroad as well as at home. The one difference is that he is away from home, a stranger in a strange land, and that he is a representative of his country among the peoples in whose land he is a guest.

Most foreign oil operations, even those with separate corporate structures, are subsidiary to and owned and controlled by corporations with head offices in New York, London, Pittsburgh, or The Hague. The policies that govern the foreign operations and particularly the operating and financial programs are determined at high levels in the home offices. Effectively the staff operating in a foreign country operates at about the same level as that of a division office at home. The one important difference is that the staff has the extremely important function of maintaining friendly relationship with the government and people of the nation in which it operates.

Let us consider the nature of a foreign oil operation. In the first place the mother company sends geologists to study and report upon areas attractive for oil exploration. Assuming that their report is favorable, negotiators are sent to acquire leasehold or concessionary rights. Either or both of these operations may be and often is of a transient nature. The geologists make their reports and move on to other fields or even countries. The negotiators conclude their tasks and move on.

Permanent or quasi-permanent operations begin with the drilling of the first wildcat well. The operation is small and is strictly technical. It is desirable that organization be kept to a minimum. The manager is likely to be a technician, a drilling superintendent. Even when the operation requires more personnel than is necessary for the drilling of the well (road builders, accountants, geologists, petroleum engineers, and even representatives to the government) the drilling of the well is the important thing and the drilling superintendent is likely to be the man in charge, the manager.

Let us consider the nature of personnel in this phase of foreign operations. The management and staff are foreigners to the country in which the operation is to be conducted. The roughnecks and truck drivers are likely to be foreigners. The machinery with which the work is to be done is foreign built. Even the food and much of the housing accommodation for the men likely are imported.

The whole operation resembles nothing quite so much as a small invasion by an expeditionary force during wartime. The only natives of the country who are employed (this includes initial operations in a foreign country) are for crude and unskilled labor. Occasionally a lawyer, civil engineer, or interpreter of the nationality of the country in which the operation is conducted may be employed. The foreigners, relatively speaking, are a pampered lot. They receive higher wages than they would at home as an inducement to take up foreign work. They must be well fed with food of the type to which they are accustomed at home. Even the cook is likely to be imported. On the other hand, as only unskilled laborers are used from the native population and the supply generally exceeds the demand, wages for the unskilled are generally low and, for the most part, they supply their own commissary.

The condition that has been here described as characteristic of the initial oil operations in a country is unfortunate but inescapable. The job can only be done by foreigners.

This is true for all countries in initial exploration for oil. I remember well the crew of some 40 American oil field workers brought to England during World War I to drill the initial wells in Derbyshire. Again I remember with

The Author

E. DeGolyer is head of the geological and engineering consulting firm of DeGolyer and MacNaughton. Recently elected to honorary membership of the American Institute of Mining and Metallurgical Engineers, DeGolyer has spent the greater part of his life in the finding of oil-producing areas of the Western Hemisphere. He discovered the famous Potrero del Llano No. 4 in Mexico in 1909, which has produced more than 100,000,000 bbl of oil. In 1919 he and Vincent Cowdray organized the Amerada Petroleum Corporation and in 1925 its subsidiary, The Geophysical Research Corporation. The U. S. government has called on him many times for advice and service. He is a charter member of the National Petroleum Council, the Military Petroleum Advisory Board and the Advisory Committee on Raw Materials of the Atomic Energy Commission.

†Presented before the Petroleum Engineering-Management Conference at the University of Oklahoma, March 14-15, 1952.

pleasure having coffee during World War II with Lloyd Noble's group of American oil field workers at Kelham Hostel, an extremely high church seminary, almost a monastery in fact, in the north of England where they were billeted. These men were developing the small English fields of Eakring and Duke's Wood. Obviously the need to import skilled oil field technicians is not restricted to the underdeveloped areas of the world.

Assume that exploratory efforts are successful within a year or two, surely not too short a time, and that an important oil field is discovered. The little organization of perhaps less than a score of foreigners is no longer adequate. Pipe lines, tank farms, and loading wharves must be built. Many wells must be drilled. Perhaps a refinery will be built. Technicians are required by the hundreds where they were formerly employed by the tens and again they must be imported.

The problem of public relations first becomes really important and from this point on will become increasingly important. The initial organization with its score of imported foreigners cannot have had contact with the native citizenry over too broad a perimeter. As the operation expands, however, it may become great enough to seriously influence if it does not dominate the economy of its host nation as it has in many of the countries of the Middle East. If the technician comes to the top or stays on the top it is likely to be because he has demonstrated qualities particularly suited to management of foreign operations as well as the abilities normally expected of management.

What qualities and abilities are desirable in the management of foreign oil operations beyond those that are ordinarily required for management of domestic operations on a comparable scale? Three such requirements are immediately apparent. Management in foreign operations must be able to plan further ahead than in domestic operations. It must be able to arrive at independent decisions, often of considerable moment, in time of emergency. Above all it must be of a friendly nature and able to initiate and maintain friendly relationships and mutual self respect between its foreign staff and citizens of the host country.

As to planning far ahead, it need only be noted that in a foreign field the operator is far from his base of supplies. Even in this age of air transport, a broken piece of machinery may cause delay of weeks in a drilling operation. I visited the Middle East a few years back and was the guest at his house in Haifa of M. M. Stuckey, then local manager for Iraq Petroleum Corporation. Mr. Stuckey had built the initial pipe line from the great Kirkuk field in Iraq, to the ports of Haifa and Tripoli on the eastern Mediterranean. This was a big and difficult operation and upon its completion Stuckey had been honored with decorations by the various governments concerned. I was examining the diplomas for these awards, which hung on the walls of his living room, when their owner entered. I congratulated him upon having accomplished a work which merited such awards. Pink cheeked Stuckey was as American as apple pie. He giggled. "Wasn't any job at all," he said. "Nothing to it. Just a matter of having the men and pipe at the right places at the right time!" I have often thought that this modest man had put his finger on the very essence of management "just having the men and pipe at the right place at the right time."

Management must be able to make firm and important decisions when necessary. In this day of rapid communications, messages may be sent across the world and answers received in a matter of hours but emergencies can arise that will not admit of a delay of even a few hours. Situations have to be met that are too complex to be explained in great enough detail to the head office to admit of their making decision as good as those that can be made upon the ground. A case in point was the decision that had to be made regarding the evacuation of American oil field workers from the Mexican oil regions at the time of the American occupation of Vera Cruz in 1914. Obviously this was an emergency that could not await decisions to be made in London and New York.

As to management's responsibility for maintaining proper and friendly relations between its staff of foreigners and citizens of the country in which operations are being carried on, this is a big and important subject. The subject is one upon which a book could be written without beginning to exhaust it. I hesitate to cite a single case for fear of appearing to oversimplify the problem but one so much to the point has recently come to my attention that I will risk it and amplify the problem afterwards. A few months ago I met my old friend Burt Hull at a luncheon in San Francisco. Hull, who built the Big and Little Inch pipe lines from Texas to the East coast during the last war, was on his way back from the Middle East where he was just completing the construction of TAP line, the pipe line that crosses the peninsula of Arabia from the Persian Gulf to the Mediterranean seaboard. He had a worried look and I asked the cause of his troubles. "Did you ever try to water 50,000 camels?" he asked. I had not but I was an avid listener. He hauled out a handful of pictures from his pocket. There were more camels together than I had imagined could be possible. It appears that Mr. Hull had been drilling water wells at the pump stations along the thousand miles or so of desert crossed by the line. Nomads had heard of these new oases and they had come in for water. Now the desert had ancient laws of its own regarding hospitality and I suspect that the first law is that water cannot be denied to man or beast. The wells originally drilled could not supply sufficient water for this extraordinary demand and supply the station. "What are you doing?" I asked Hull. "Just drilling more wells," he replied with a rueful grin.

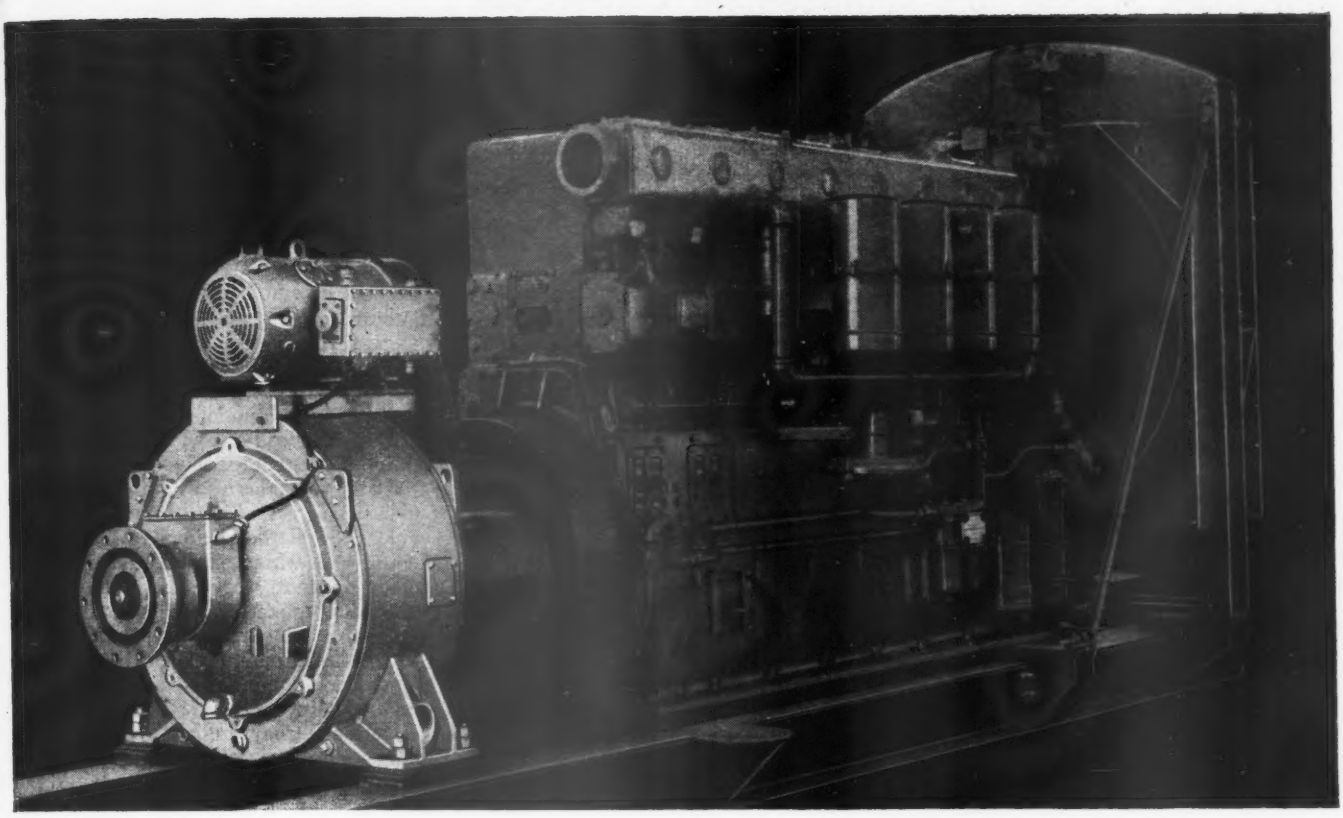
Perhaps I should not attempt to point the moral to this tale but I am tempted to try. I suspect that Mr. Hull could have appealed to the authorities and had his wells forbidden to the men of the desert. To have done so would have solved his problem quickly but could have left a black mark against his enterprise not to be removed by a generation of good works. Wise Hull solved his problem by "just drilling more wells."

There is no more important problem than that of human relationships in foreign oil operations. It is a most difficult one to solve. There are basic differences between the imported oil men and the natives in language, in political and social viewpoints, and in religious beliefs. As important as these is the unavoidable difference in economic status and consequently in the treatment of the imported skilled technicians and the native unskilled labor, to which I have already referred. Generally the incoming foreigners are transients. They do not become citizens of the country in which they work. With few exceptions they expect to work out their contracts, save a stake, and return home within a few years. Most of them make no serious attempt to learn the language of the host country and rarely do any of them study its history and customs.

The solution of this problem, as the companies have learned through long and bitter experience, is to make technicians of native labor and with them replace the imported technicians. A generation ago all oil wells in Mexico were drilled by American drillers and tool dressers. Today deeper and more difficult wells are drilled by crews entirely Mexican. The wells of Venezuela are being drilled by Venezuelans and I am informed by responsible authority that within a year or two American drillers now working in Arabia will be replaced by Arabian drillers now in training.

A survey made a year or two ago, before the recent Iranian nationalization of its industry, showed that approximately 130,000 men were employed in the field forces of various areas in the Middle East and that 85 per cent of such forces were citizens of the country

Poor communication between engineers and top management is causing estimated loss of 60 per cent of potential managerial talent of engineers, reports the National Society of Professional Engineers, Washington, D. C. Survey of 350 companies employing some 50,000 engineers disclosed that only 34 per cent of companies have any planned program of information to prepare engineers for management leadership.



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in which they were working. For Iran and Iraq where operations have been going on for a long period, 95 per cent of the field employees were citizens. For the other producing countries of the Middle East where oil operations are of much more recent origin and still in an expanding state, only 70 per cent of the field forces were citizens of the country of operations. Obviously, it is to the advantage of the countries in which operations are being conducted and of the interested companies that the imported foreigners be replaced by citizens as rapidly as they become trained to hold highly technical jobs.

At this point and while still on the subject of public relations, it may be well to sketch something of the history of the slow development of consciousness on the part of the companies of obligations toward their native unskilled employees. In the earliest of the big scale foreign operations, that in Mexico during the early decades of the present century, unskilled native labor was paid merely its wage. Some little medical care was given in case of accidents and emergencies. Housing, community life, schools and recreation were no concern of the companies. I have seen squads of men come down from the hills, bringing a few tortillas with them for food. They worked a few days, slept in the brush, took their wage, and went back to their homes.

The next large scale foreign operations were by the British in Iran and by the Americans and British in Venezuela. The Mexican mistakes were not repeated. Indeed, through the camp system, the companies became too paternalistic and assumed functions in the way of education and social service which should have been those of government. The chief operating company in Venezuela, as an outstanding example, in 1949 cites among the various activities with which it is associated, 9118 housing accommodations with necessary utilities, 22 hospitals and dispensaries, 14 primary and three secondary schools, 25 sports and recreational clubs, 19 playing fields, 22 commissaries and five churches; all of these for just under 21,000 employees.

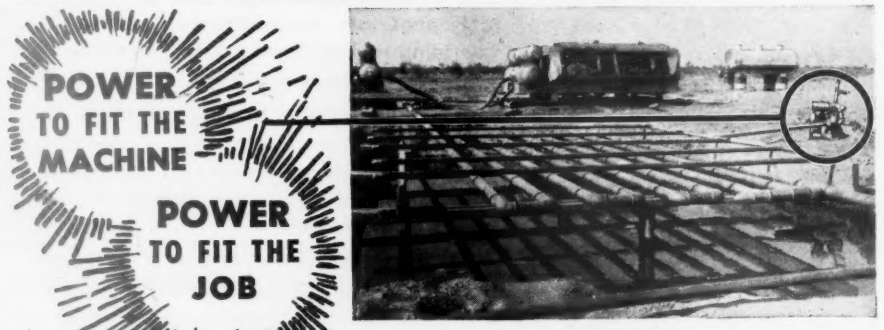
The most modern and, it seems to me, the most satisfactory method for taking care of employees is that which I am advised is being adopted by Arabian Oil Company for its Arabian operation. After long study of the problem, the company is proceeding to the establishment of towns where necessary or additions to existing towns. It will supervise the proper lay out of such towns or additions, the building of suitable housing and provision of necessary facilities. It is proposed that these towns be as independent and self administered as any other Saudi Arabian municipalities. Through financing of a building and loan type it is proposed to help employees to purchase their own homes. The forward step in these proposals, it seems to me, is that the resulting towns or additions to towns will be in no sense company towns. This is an important point and I should like to quote here the pertinent conclusion that I have stated elsewhere on another occasion.

"It is to the advantage of the state and of the company for the latter to confine itself strictly to its proper business of producing, transporting, refining, and marketing of oil. In a pioneer operation the company must engage in many additional activities in order to care properly for its employees but, as conditions stabilize, the state can advantageously assume functions now performed by the companies and the companies can advantageously retire from the performance of such functions."

One may well ask where it is possible to obtain expeditiously and in a compact package the information needed as a basis for a real and sympathetic consideration of the nationals of a foreign country in which one may be called on short order to work. Almost any guide book will make a good beginning. The United States Army published a series of excellent pamphlets during the last war. Each pamphlet covered one of the countries in which it was expected that American troops might be stationed. The pamphlets were particularly valuable in stressing things that should not be done for fear of offending citizens of the host country. Whether copies of these pamphlets are still available I do not know. Also, during the war, the Oxford University Press published a series of compact guides in its *The World Today* series. Whether this series is extensive enough to be serviceable is doubtful. At least there are volumes for Canada and the United States that we could read with profit.

Best of all, perhaps, are hand books prepared by the companies themselves. How much has been done in this direction, I do not know. I have read the first edition of the *Handbook of the Territories which Form the Theater of Operations of the Iraq Petroleum Company, and its Associated Companies*, published in 1948. It is an excellent and concise description of the company and of most of the nations of the Middle East. I commend it to you as a model. It is tightly written, more than covers its field, extending to subjects from modern society to archeology and includes bibliographies for further reading. It is to be hoped that so excellent an example will inspire other companies operating in little known areas to prepare similar hand books.

In closing, may I summarize and bow again to the subject assigned to me. Aside from the necessary competence in their own specialized field of endeavor there is nothing half so important to the personnel of a foreign operation nor to the enterprise as a whole as sympathy and friendship of the operating staff with the citizens of the country in which they work. Such friendliness may not make a manager of a technician or even of a technologist but given equal competence in managerial skills, the friendly candidate for advancement should and is likely to get the nod. * * *



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— Ing. Jorge Aldazosa* . . . —

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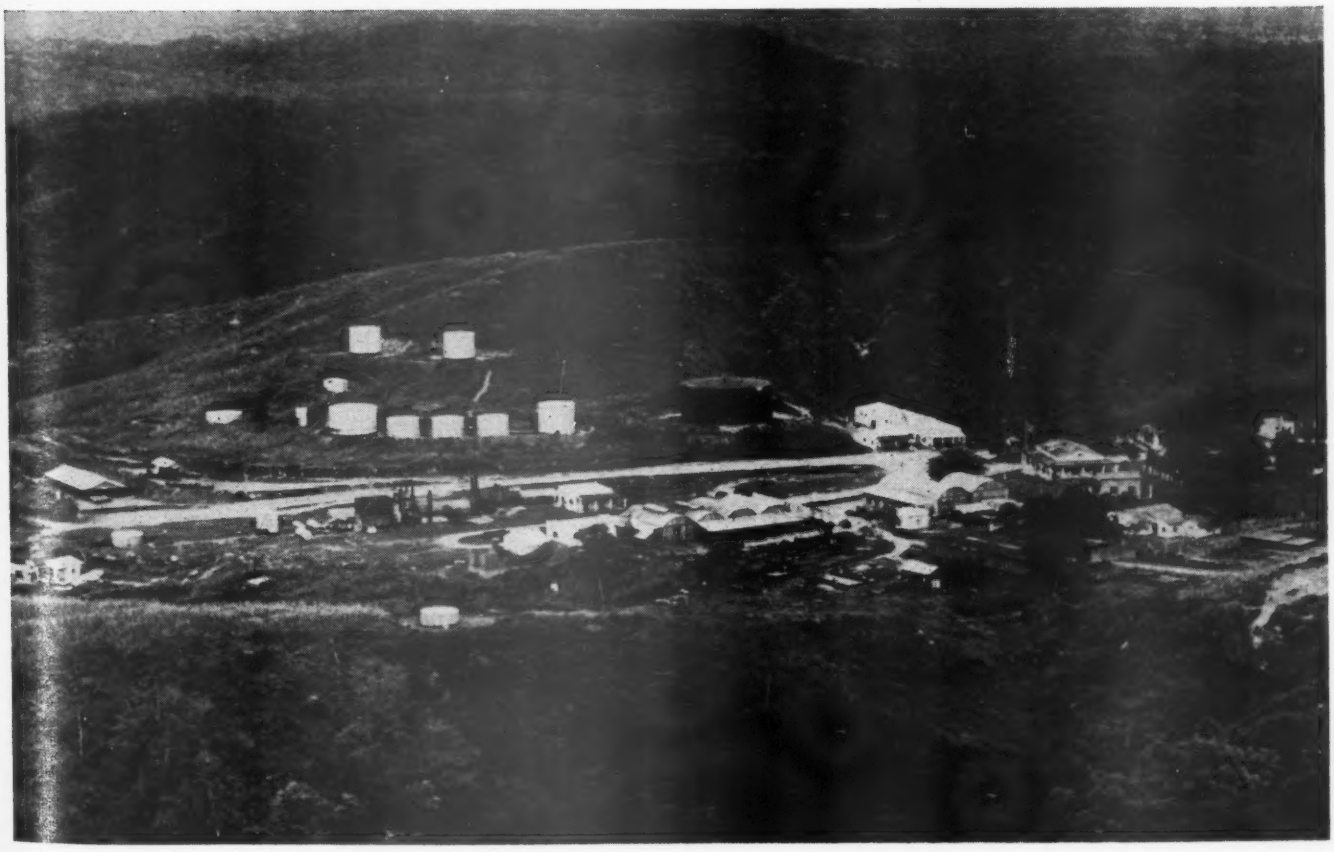
The lack of materials was what prevented a greater number of wells from being drilled, a situation that has changed during the second six months of 1951 in which 3102 meters (10,082

*Production Manager, Yacimientos Petroliferos Fiscales Bolivianos.

Partial view of the camp at Sanandita.



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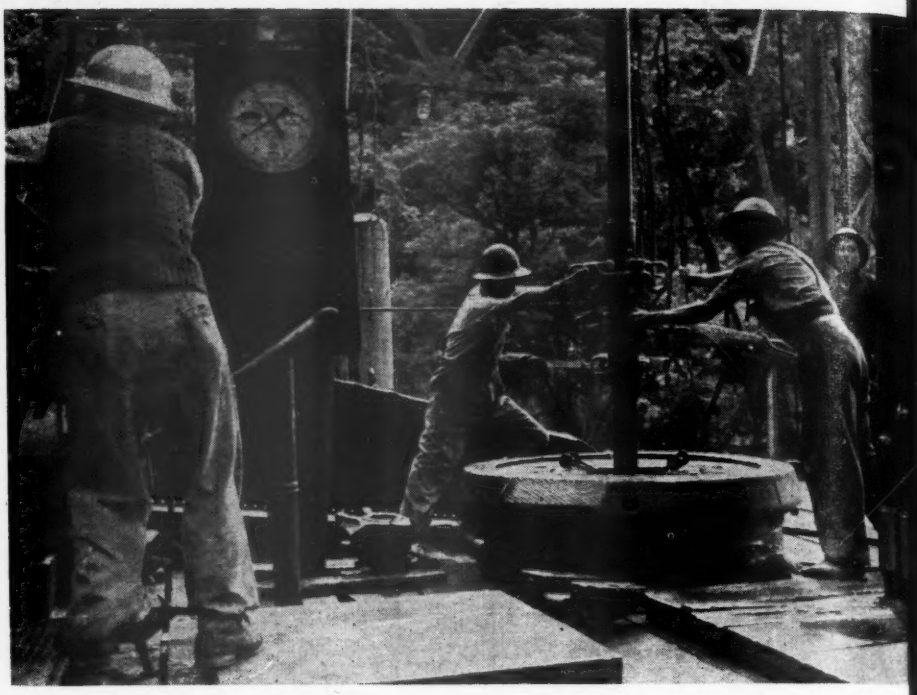

Rotary equipment in operation at Camiri.

ft) were drilled having completed four productive wells in the Camiri field.

In October of 1950 the refinery of Valle Hermosa (Cochabamba) was officially inaugurated with a 5000 bbl a day capacity, and in May of 1951, in the city of Sucre a new plant for 3000 bbl a day was completed. These refineries were constructed by Foster Wheeler Corporation and increase the petroleum refinery capacity in Bolivia to 10,860 bbl daily.

The drilling of exploratory well LM-1 was continued in the Los Monos structure situated 40 Km to the north of Sanandita. This well encountered gas and oil at the depth of 881.70 meters at pressures greater than 2200 lb psi, which prevented completion with cable tools.

During 1951, YPFB initiated efforts for obtaining a credit that would permit it to realize an intensive program of drilling in its fields. Efforts are considerably advanced and will possibly have favorable results. In such case, YPFB will invest the credits principally in modern rotary drilling equipment and tubular material to be used in new wells, with such equipment and material to continue the development of the Camiri-Guairuy field with the idea of completing the development of same in the shortest time possible. At the same

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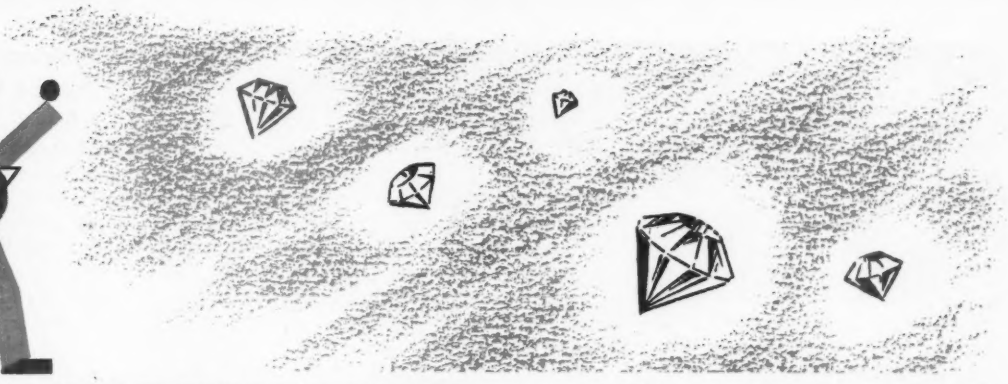

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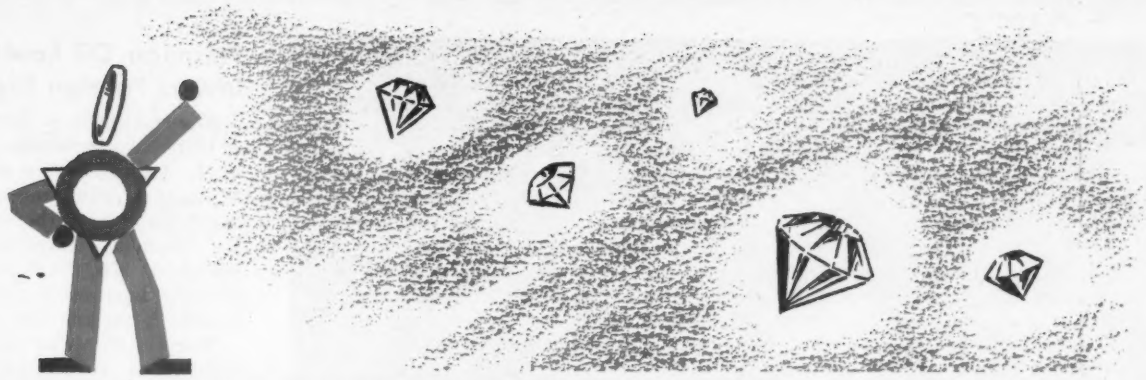

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A winding road in the Sanandita field, in which can be observed the difficult topography of the zone. Two batteries of gas separators can be seen in the picture.

time, it will initiate the intensive development of the Bermejo field located on the border between Bolivia and Argentina, and of the field of the Los Monos recently discovered and located only a few kilometers from the Yacuiba-Santa Cruz railroad.

During 1952 it is also hoped to drill exploratory wells in the Toro-Barredero structure north of Bermejo and in the Mandeyapecua structure.

Actually, YPFB is attempting to modernize its methods of operation, having almost completely done away with cable tool methods; on the other hand during 1951 it has executed contracts with Schlumberger of Latin America S. A. and with Western Geophysical Company to obtain their technical services.

In addition to the operations of YPFB, the fiscal reserve of a vast Bolivian zone has been raised, and a new law to encourage foreign companies to invest capital has been passed. The policy of reserving oil fields no longer extends to such zones as the Provinces of Caupolican and Iturralde in the Department of La Paz, the Provinces of Ayopaya and Chapare in the Department of Cochabama and the Departments of Beni and Pando.

Completion of the 5000-bbl capacity Cochabamba refinery has raised the refinery capacity to a figure higher than its consumption. Refinery runs at present seem to be domestic only. * * *

Peruvian Oil Law Change Invites Foreign Exploration

The end of over a quarter of a century of restrictive legislation and the opening of the vast resources of Peru to active exploration and production by foreign capital is seen in the recent passing by the Peruvian government of a new petroleum law, the Braniff International Airways business bureau head, Warren Kraemer, has announced.

The old Peruvian oil law was so restrictive, it discouraged foreign operators from participating in the Peruvian industry, said Kraemer.

"The new law recognizes the inherent risk in oil exploration and development work and the need for a reasonable profit," he added, "while at the same time the national welfare of Peru is adequately protected against abuse of a vital natural resource."

Under the new law, foreign concessions will not be granted within 50 kilometers of the national frontiers. Also, prior to exploration, any area may be declared a national reserve. As an example, the entire maritime shelf is already restricted for this purpose.

Oil concessions will vary in size according to their geographic location in various zones. The government automatically obtains one half of the area chosen, for use either as a "free zone" or as a national oil reserve.

Peruvian development concessions are for a fixed but reasonable period of time, after which the land and all installations revert to the government at no charge.

Applications for refining concessions will be received in the same manner as those for exploration and development.

The holder of a Peruvian development concession is also automatically granted the right to set up transportation facilities, such as pipe lines, pumping stations, and storage tanks.

The holder of a exploration concession will pay a nominal tax to the government. Once the development of an area has begun, the tax increases and will continue to go up on a set scale. Royalties paid to the government are as follows: 12½ per cent for the Coastal Plain, 6 per cent for the Sierra, and 3 per cent for the Eastern Lowland.

The royalties on Peruvian oil will be payable in cash or royalties at the option of the President. The same scale will apply to natural gas.

"It is interesting to compare the Peruvian oil royalty rates with the 16 and one-third per cent rate currently being applied in Venezuela," states the Braniff Airways report, "where, of course, the production is enormous and pattern for development defined."

Although other business taxes will be levied against the operation of oil development concessions and transportation concessions, there will be no tax on the export of oil.

This is an important reversal of the historic practice of taxing exports and is designed to develop a world market for Peruvian oil.

Lubricating and Fuel Oil Filters —Their Use and Service—

J. F. AUSTIN

IT has been pointed out in a previous article, that, a "clean engine program", means long lived and comparatively trouble free engines. The manner in which the lube oil-filter and the fuel oil-filter affects the accomplishment of a clean engine, and the type of service such filters require, is discussed in this article.

The true value of the lube oil-filter was for many years a much mooted question. Today virtually every engine manufacturer uses one of the many available lube oil filters as standard equipment. They would hardly risk sending an engine into service without one.

There are two specific classes of lube oil filters:

1. **By-pass filters**
2. **Full-flow filters.**

A so called "by-pass" filter takes only a small portion of the oil being pumped into the main lubricating oil channels. A so called "full-flow" filter takes all the oil from the pump and forces it under pressure through the filter before it reaches the main oil channels Both types of filters have very definite advantages for given operations. A combination of the two types, particularly on diesel engines, produces the best possible end result.

To obtain satisfactory filtration from a by-pass filter on gas, gasoline, butane, or propane-operated engines the crankcase oil should be cycled 6 to 8 times per hour. The rate of dirt formation with such fuels is comparatively slow, once the critical or starting period is passed. The flow that has occurred during this critical period is quickly cleaned up by the by-pass filter. Semi-collodial carbon or "aspheltenes" cause sludge or engine varnish to form, which depends upon either high or low temperature in the engine. "Aspheltenes" of oil along with dirt, moisture, and low temperature result in "sludge". "Aspheltenes" at high temperatures quickly deposit in the form of engine varnish. Most "by-pass" filters are designed to prevent either of these formations, or to remove the effects of such formations promptly if they occur.

By-pass filters of the cellulose type will also act as an active acid neutralizer. Neutralization is accomplished by a scorching or burning of the cellulose fiber. This is more simply explained by example: A man spills some battery acid on his pants, it doesn't burn his pants off but merely burns a hole in them—the acid has burnt itself out and is neutral! The value of by-pass filters is:

1. **To prevent sludge and engine varnish.**
2. **To neutralize acid.**
3. **To cleanse the oil and maintain nearly new oil conditions while in use.**

Unless severe local dust conditions exist this type of lube oil filtration is usually adequate to keep the crankcase clean.

The full flow filter is designed primarily to remove all solids from the oil as it is pumped from the oil supply to the oil channels of the engine. In usage it removes solids down to a few microns in size, thereby protecting the bearings from abrasives that would result in short bearing life, and under severe dust conditions rapid crank-shaft wear.

In the case of a diesel engine, where the critical as well as the operating periods produce a greater amount of carbon solids, and if operating in a dusty area, a full-flow filter is almost a must!

Where "full-flow" filters are used it is extremely important to keep a close check on the engine pressure gage. As the filter is filled with dirt a resistance to flow is built up and the oil pressure drops. When a drop of from 5 to 7 lb in pressure is noted the cartridges of the "full-flow" filter should be changed at once. It is possible to permit a 10 lb pressure drop occasionally without serious damage to the engine, but in general the 5 to 7 lb limit should be observed.

As the "full-flow" filter is designed for the removal of solids and does not have any neutralizing effect on acids, and cannot remove "aspheltenes" of oil that the average "by-pass" filter will, a good plan is to use both filters in combination. The "full-flow" for catching the solids and to protect the bearings from abrasives, and the "by-pass" filter for keeping the oil chemically clean.

The period of usage in hours, or miles, for any oil can be determined only by an oil analysis with the filters in use. A radical change in conditions should be followed by more analyses to determine whether or not an alteration in the maintenance schedule has become necessary. Almost any of the oil producers or filter manufacturers will be pleased to work with an operator in setting up safe maintenance schedules for lube oil usage.

With the old straight mineral oils this was a simple matter, but detergent type oils complicate the problem. It is generally agreed that with the newer heavy duty oils, lube-oil-filters are essential. As the dirt is finely held in suspension, in the oil, by the detergent an efficient filter should be employed. The problem then arises of how long a properly filtered detergent oil can be used without being changed.

Here, once more, we must go back to the ever reliable method of oil analysis. But in addition to normal oil analysis, we must determine how much of the detergent has been removed from the oil. Usually the detergent taken out of the oil will be in a direct ratio to the dirt removed. The only variation from this rule would be the use of a filter whose media would in themselves remove detergents from the oil. None of the cellulose type filters have an effect

The Author

J. F. Austin is manager of oil field and industrial division of Deluxe Products Company. He studied radio in Washington, D. C., in 1917 and '18, when he went to sea as a first grade radio operator, U. S. shipping board. He left radio work in 1921. He joined the New York Central Railroad, Cleveland, Ohio in late 1921 to 1926 attending state prep school and John Marshall Law school nights. He worked for Dupont Paint and Varnish Division from 1927 to 1935, joining Sherwin-Williams Company as district manager in Kansas City from 1935 to 1936. For the next three years he was field superintendent for The Arco Company, going with Deluxe Products Company in 1940.

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This is the second of a series on engine maintenance. Other articles will follow, each giving specific information on good cleaning practices to promote the highest engine efficiency.

on detergents. Earth types and some chemically activated types will remove all of the detergent from the oil. For this reason care should be used in selecting filters for detergent oils. As a rule of thumb if 30 per cent of the detergent has gone, the oil should not be considered for further use. The reason for this is that a considerable portion of the washing or cleansing action of the oil is lost, so it is time to change the oil.

Clean fuel to "feed" the engine is as important as clean crankcase oil to lubricate it. In fact one complements the other. A good diesel fuel with a cetane rating from 35 to 42 and which is kept clean by efficient filtration will operate the diesel engine without any signs of "indigestion". The higher the cetane rating and the cleaner the fuel the greater is the horsepower output; and so a more efficient engine is available.

Dirty fuel causes injector nozzles to plug up easily. This means down time. Because dirty fuel cannot be burned efficiently and the products of "blow-by" of combustion get into the crankcase oil and throw an extra burden on the lube oil-filter Sludge and engine varnish formations are the result. The most efficient fuel oil-filter money will buy is none too good. It will pay for itself many times a year.

The general use of field gas with gas burning engines requires more than scrubbing for clean fuel. Many lube oil problems are a result of poorly cleaned field gas. Attention to this problem will pay big dividends in engine maintenance cost. * * *

Gasoline Demand Up More Than 8% in 1951

Domestic demand for gasoline in 1951 rose more than 8 per cent for the second consecutive year, the American Petroleum Institute reported. The increase was 8.05 over 1950. It reached an all-time high total of 43,888,727,000 gal, more than 3 billion gallons above the 40,617,285,000 gal consumed the previous year.

Record consumption of motor fuel coincided with a sharp rise in automobile registrations. These jumped 6.3 per cent in 1951 to a total of 42,846,000 estimated by the Bureau of Public Roads. The preliminary Bureau estimate indicates that truck and bus registrations rose 5.9 per cent to 9,353,000.

The top three gasoline-consuming states retained their 1949 and 1950 positions. California was first with 4,390,157,000 gal; Texas next, 3,514,073,000, and New York third with 2,787,670,000.

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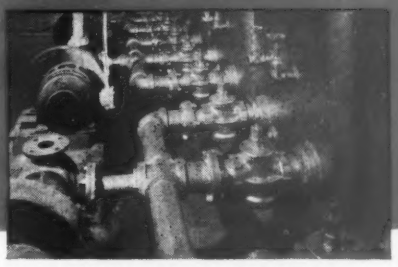

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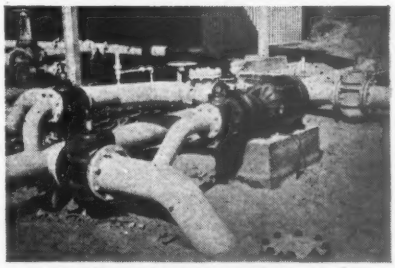

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Petroleum Profile

A. P. FRAME
President
Cities Service
Research
and Development
Company

For most of the last 10 years A. P. (Al) Frame, president of Cities Service Research and Development Company and vice president of Cities Service Refining and of Cit-Con Oil, has emulated "the Irishman's flea" in his several changes of responsibilities. Al has just returned to his home company after his second hitch in Washington as industry's manager of petroleum activities there, to take up again the multitudinous duties of his New York headquarters.

The beginning of World War II found Al Frame as vice president and chief engineer of Cities Service Refining Corporation, the so-efficient refining unit that literally "sprang full-grown from the forehead of Jove" or it might be revised to "Mars" out of the water hyacinth-infested swamps of southwestern Louisiana. Building too speedily, with too little almost too late, that plant went up under the push of Cities Service and Kellogg engineers to become one of the outstanding refining machines of our time. It was an interesting but far from an enjoyable thing, then, to see men hammering away when so tired they could have slept on horseback.

From there, after the plant was on stream, Frame went to Washington as refining director in that well-ordered and hard-working nightmare Petroleum Administration for War, piloting the efforts to produce enough gasoline and oil and fuel to power the two-front war. Back with his company at war's end he headed the organization and developed the sphere and work of Petroleum Advisers, Inc., the Cities Service organization's co-ordinating company for petroleum operations. This company recently has been renamed Cities Service Petroleum, Inc., and Al was made first vice president of this company, president of which is B. S. Watson, executive vice president of Cities Service Company.

For remobilization of our military resources the Petroleum Administration for Defense was formed in 1950, and Al Frame was one of the organizing executives. There he remained through 1951 as aviation gasoline program director, assistant deputy administrator, and eventually associate deputy administrator.

Al was born a citizen of our neighbor to the north, in Nova Scotia about the turn of the century, and was graduated with a bachelor of science degree from Dalhouse University at Halifax in the same province. Traveling soon after to where the gas and oil fumes were thickest, he worked for three years for National Products Company, making natural gasoline, went to Cities Service in 1924 as plant engineer at Ponca City, was made superintendent at Petty's Island in 1928. All this broadened vision and enriched experience, until 10 years later he was promoted to assistant director of refining and transferred to the home office, which is situated in New York City.

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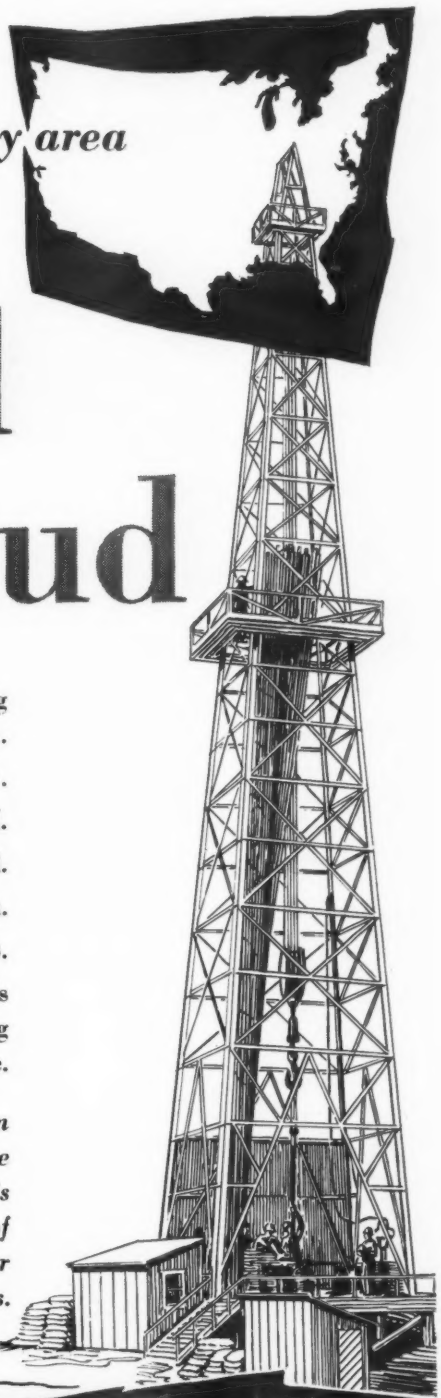

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Corrosion Impairs Production

Corrosion is costing the drilling and production departments many millions of dollars annually, not to mention the astronomical costs caused by this destructive agent in the other phases of the oil industry. The cost to combat corrosion, the wastage of material, and the loss of revenue is so great that a special committee, and eight subcommittees have been formed under the auspices of the National Association of Corrosion Engineers (NACE). H. L. Bilhartz, Atlantic Refining Company, is chairman of this Technical Practices Committee, Oil and Gas Production. They are laboriously attempting to appraise the corrosion situation, and to study processes most suitable for the mitigation of corrosion. Although the committee has a formidable task, a step has been taken in the right direction. The Association is to be congratulated on such a decision.

For many years corrosion was considered a natural and expected occurrence, and little thought was given to preventive measures. In recent years considerable research has been conducted, but the future calls for a continued and greater effort to combat this enemy of the oil fields.

Corrosion can be generally defined as an action, or effect that causes the wearing away, or the disintegration of metals by either a chemical or electrolytic process. The principal agents of oilfield corrosion are carbon dioxide, hydrogen sulfide, and organic acids.

Field corrosion problems have become so severe and complex, both scientifically and economically, that some oil companies have a corrosion department that functions both in a research and administrative capacity. A new type of engineering has been introduced into the industry, and the day is not far distant when all oil operators will consider such a department essential.

The national emergency with its attendant steel shortage has automatically accentuated the need for the conservation of equipment. Producers confronted with corrosive wells find that the injection of inhibitors minimizes tubular, and production equipment consumption, but an important economical consideration often arises. Today, due to the steel supply situation and the possibility that replacement equipment will be unavailable, many find that it is paradoxically more economical, within prescribed limits, to have a costlier corrosion-inhibiting system than one of replacing the material when it is corroded. When evaluating corrosion mitigation with that of a no mitigation policy, cognizance must be taken of the fact that, not only has the corroded material to be replaced (this material may have a salvage value), but well pulling costs, and lost production are also financial factors to be included in the equation.

Inhibitors have been employed in corrosive high-ratio water type marginal wells, and have successfully maintained trouble-free and economical production.

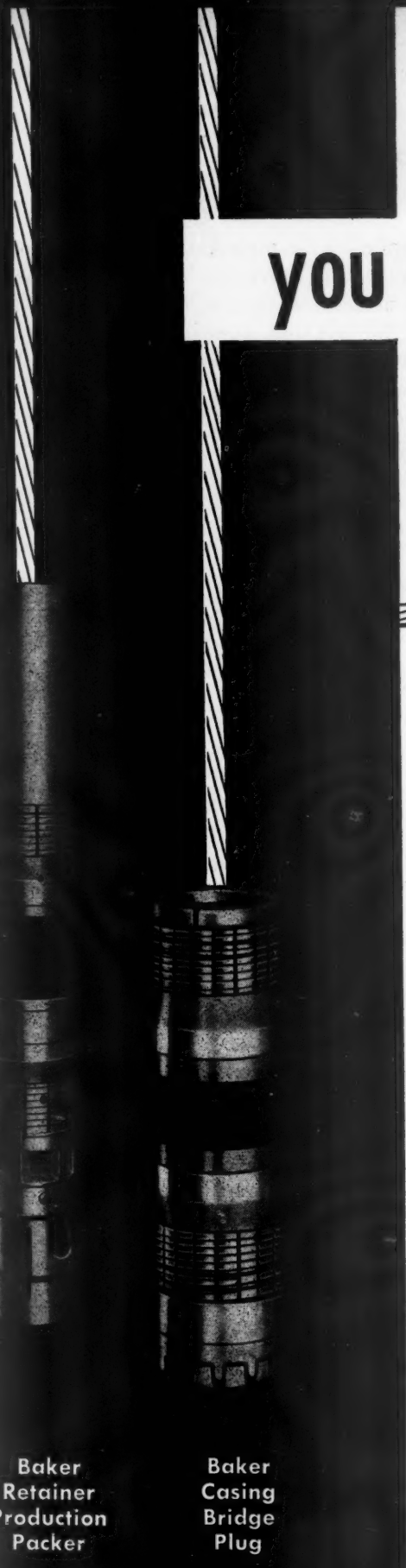
Equipment that is subjected to stress and strain variations, such as drill pipe and sucker rods, frequently break off. This is often, and correctly, attributed to corrosion-fatigue, which is initiated by a corrosive contamination of the flow stream constantly attacking the metal. An area of weakness is created and eventually a complete fracture occurs.

A survey of the downtime due to corrosion-fatigue would show in one year the loss of many thousands of barrels of oil. This loss can be partially remedied when the exact cause of corrosion is known, but this is often difficult to determine. Special scientific devices are available for inspecting oil well equipment for signs of corrosion-fatigue, and such methods can be advantageously adopted for avoiding future down-the-hole troubles.

Several techniques are employed for combating corrosion and each has its particular merits. The injecting of chemical inhibitors, in either liquid or solid form, has proved successful in many instances, and particularly in low level fluid wells. Attention is being directed to wells having a high fluid level. Because of the mass of fluid to be penetrated in the casing-tubing annulus, difficulty may be experienced in having a sufficient quantity of corrosion inhibitor entering the producing stream of the tubing. On the other hand special alloy products can be used, but the high cost usually makes such a consideration prohibitive. Another means adopted is that of plastic-coating well equipment, but this is not usually applicable when abrasive action occurs.

While it is gratifying to know that the battle against corrosion is now being waged, corrosion is killing production in many wells. It is a deceptive agent, and no doubt there are many who are not yet aware of its presence in their operations. Corrosion is a silent, but destructive worker.

—J.M.



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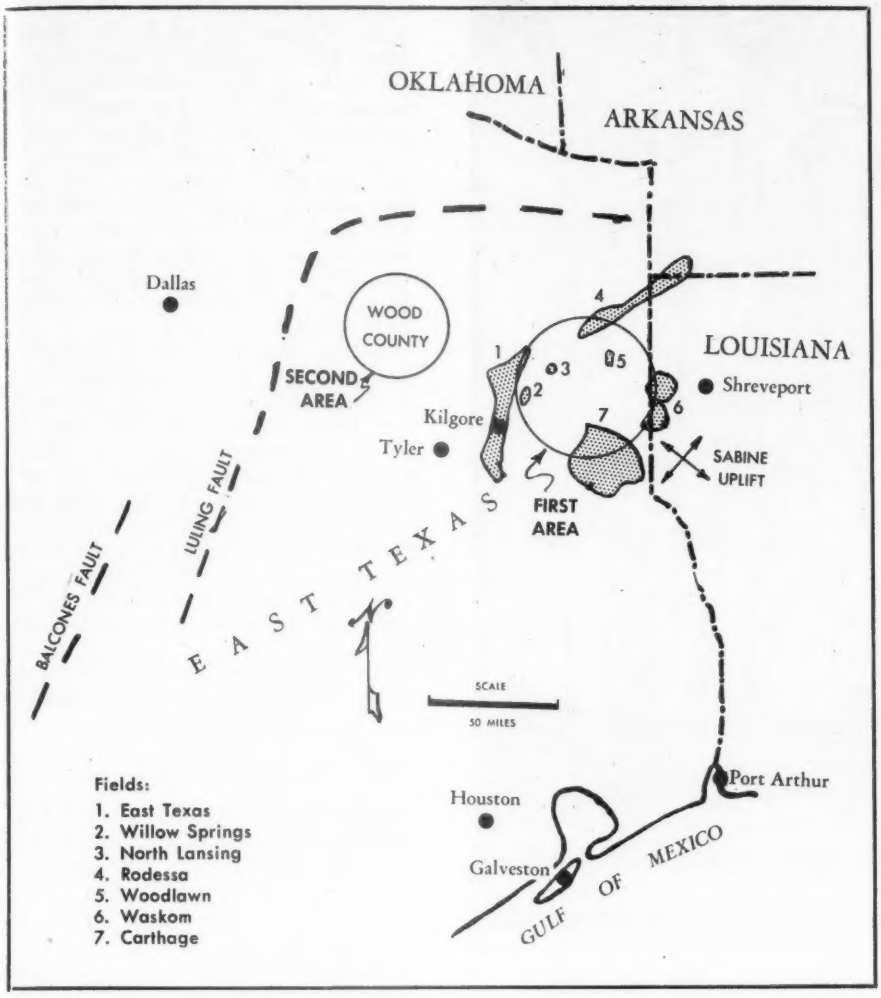

East Texas

The enormous East Texas field, which has 22,000 wells, produces from one sand formation, the Woodbine. Circumscribed areas have been chosen near this field to show the latest oil and gas trends within the East Texas region.

Although the activity is not by any means comparable to the East Texas field boom days, a considerable amount of interest has been brought to the areas of late. Oil and gas discoveries have opened up new possibilities.

Oil-Gas Areas Beyond the East Texas Field

JACK MENNEER*

SINCE the discovery of the amazing East Texas field in 1930 many have wondered, and still are wondering, what oil or gas possibilities lie in the surrounding area. This Texas field caused a tremendous boom period for many years, but the boom period has long passed.

Although the present activity in the East Texas belt is far less intensive than during the formidable early thirties, the two small areas to be considered are in effect blossoming on their own and within East Texas itself (Table 1).

The first area is obtained by taking a compass with a radius of 50 miles and drawing a circle to include the East Texas, Rodessa, Waskom, and Carthage fields. These four fields are established producers, yet a considerable portion of the area inside the prescribed circle shows little sign of many other fields. They are, indeed, conspicuous by their absence. Development of the known fields continues and also a search for others is in progress.

The second area is virtually Wood County, and centers around a point 50 miles from Kilgore to the northwest of the East Texas field.

Before studying these two areas let us take a quick look at the parent unit, namely the East Texas field (Tables 2 and 3).

The field is one of the largest known single oil sand reservoirs. C. M. Joiner discovered the 36-ft thick Woodbine sand at 3600 ft, and the initial production was 300 bbl of oil per day. The Woodbine covers 140,000 acres and has a porosity of 25 per cent, and permeability range of 1500 to 4000 millidarcies. An extensive and active water drive is present in the field, with an irregular line of advance from west to east. The original BHP was 1620 psi and is now in the order of 1000 psi. Pressure maintenance is carried out by injecting the major portion of the produced saline water back into the formation below the oil-water contact. This saline water is specially treated prior to injection.

The field has over 21,600 producing wells and the daily average water production is 500,000 bbl, and 270,000 bbl of oil. The cumulative production of the East Texas field to January 1, 1952, is almost 3 billion barrels oil, and more

TABLE 1. Production data of the East Texas field and some neighboring fields.

Field	Production During 1951	Cumulative Production to January 1, 1952	Producing Wells
East Texas	99,576,000 bbl oil	2,886,277,000 bbl oil	21,641
Carthage	366,000 bbl oil	1,407,000 bbl oil	34
	3,887,000 bbl cond*	18,222,000 bbl cond*	
	342,300,000 Mcf gas	1,405,851,000 Mcf gas	403‡
North Lansing	84,000 bbl cond	88,000 bbl cond	
	8,000,000 Mcf gas†		
Rodessa	640,000 bbl oil	59,871,000 bbl oil	200
Waskom	89,000 bbl oil	192,000 bbl oil	79
Willow Springs	78,000 bbl cond*	452,000 bbl cond*	
	10,000,000 Mcf gas	116,614,000 Mcf gas	14
Woodlawn	19,000 bbl oil	19,000 bbl oil	4
	20,000 bbl cond	20,000 bbl cond	

* Exclusive plant production. † capable of producing ‡ Inclusive dual completions.

*Editor, Drilling and Producing.

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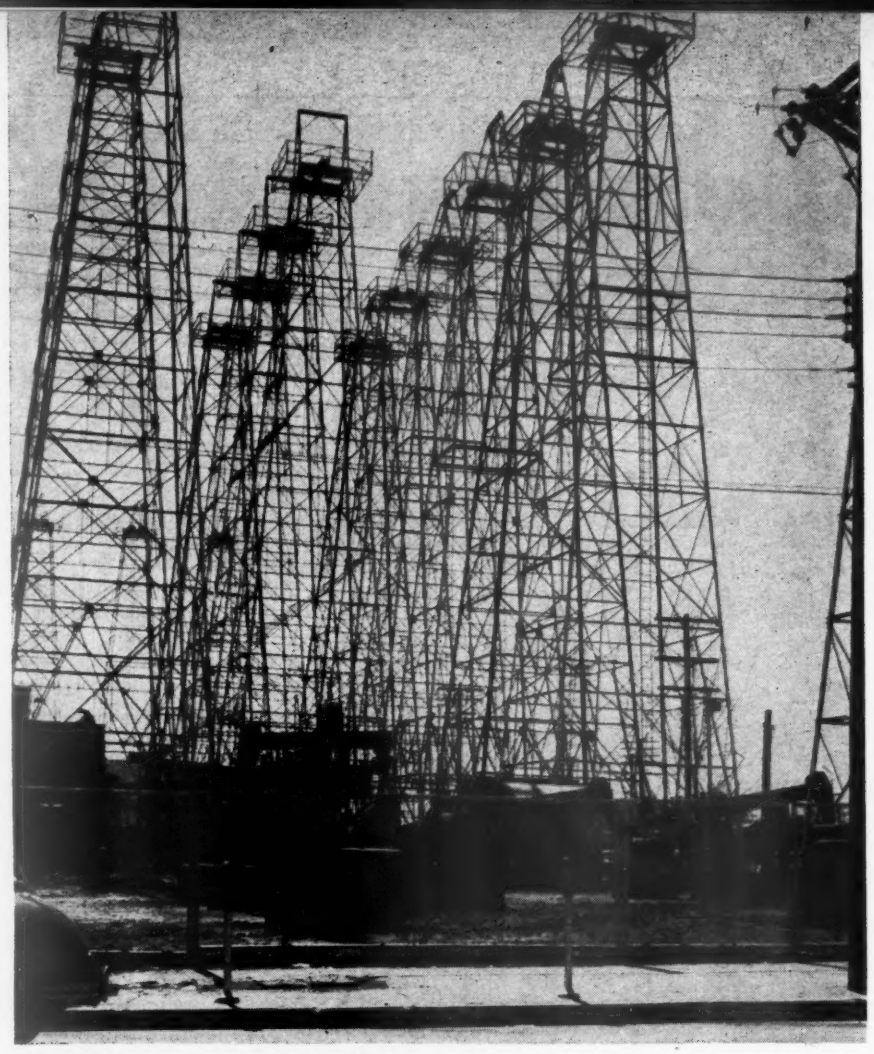


Downtown Kilgore, Texas. During the boom of the East Texas field in the early 30's, 80 or 40-acre well spacing was not the problem it is today!

than 2 billion barrels of water (Table 1), with an estimated 1½ billion barrels of water having been returned to the formation.

First Area

The major fields occurring on or within the circumscribing circle, are dealt with summarily.

In the North Lansing field, Harrison County, Atlantic Refining Company recently completed a 3,700,000 cu ft a day gas well (open flow potential) on the Bussey Davis lease where the producing formation is the Rodessa. The field's structure is an anticline without any water encroachment having been encountered and the wells are completed by perforating followed by an acid treatment of 6000 gal.

This field was discovered in 1949 when Young limestone produced, open flow, at 16,000,000 cu ft per day with 26 bbl condensate through perforations at 6760 ft. The formation has both low permeability and porosity values; the average thickness of the limestone is 75 ft. In addition to the Young limestone there is the Travis Peak limestone which produces from 7400 ft and probably has 650 ft maximum thickness.

Then there is the Woodlawn field in Harrison County. Recent open flow gas completions in the Pettit limestone were 225,000,000 cu ft in Midstates Oil's John Y. Bender lease, and 9,200,000 cu ft in R. W. Fair's et al Y. W. Medine lease. The variability of production is due to the varying characteristics of the formation. The field has, however, the prospects of some good gas production. Woodlawn was jointly discovered by Stanolind and Continental in 1947. The formation is the oolitic Pettit limestone with some 7000 proved surface acres. The gas column, which is only 24 ft in a 280 ft thick bed, is brought on to production by perforating and a treatment of 8000 gal acid.

Another perimeter field is the Rodessa, discovered in 1930, and straddles a portion of three states, Texas, Louisiana, and Arkansas; the cumulative total of all its formations would cover 47,000 acres. Faults are predominant and production, gas and oil, is from sand and limestone horizons. An interesting study was made in this field and it was found that by completing with 2000 gal acid, instead of a non-acid treatment, an improvement in bottom hole pressure decline was achieved.

The next major field is the Waskom in Harrison County, Texas, and Caddo

TABLE 2. East Texas field — as of January 1, 1952.

WELLS PRODUCING BY ARTIFICIAL METHODS, WATER PRODUCTION, AND NUMBER OF WELLS.*

WELLS	
Flowing wells making water	470
Pumping wells making water	4,403
Pumping wells not making water	4,701
Total pumping wells in field	9,104
Air and gas lift wells making water	18
Air and gas lift wells not making water	301
Total air and gas lift wells in field	319
WOODBINE WATER	
Wells making woodbine water	4,891
Marginal wells making Woodbine water	1,058
Proratable wells making Woodbine water	3,833
FRESH WATER	
Wells making fresh water	
Flowing wells	2
Pumping wells	0
Total fresh water wells	2
Daily water withdrawals:	
From all wells making water	493,072.14
From marginal wells making water	234,077.75
From proratable wells making water	258,994.39
Average daily withdrawal per marginal well	221.25
Average daily withdrawal per proratable well	67.57
Average daily withdrawal per water well	100.81
Daily withdrawal of fresh water	2.87
Other wells:	
Key wells with allowable transferred	8
Salt water injection wells	14
Total wells shown on report	9,990

* Data prepared by Engineering Department, Railroad Commission of Texas, Oil and Gas Division, Kilgore, Texas.

TABLE 3. Comparison of previous annual summaries.

	1946		1947		1948		1949		1950		1951		1952
	January	July	January	July	January	July	January	July	January	July	January	July	January
Flowing wells making water	971	743	737	669	630	675	600	459	452	450	485	488	470
Pumping wells making water	4,139	4,491	4,653	4,687	4,691	4,783	4,781	4,833	4,833	4,621	4,492	4,389	4,403
Pumping wells not making water	3,606	3,819	3,974	4,120	4,242	4,214	4,416	4,564	4,673	4,739	4,729	4,751	4,701
Total pumping wells in field	7,745	8,310	8,627	8,807	8,933	8,997	9,197	9,397	9,475	9,360	9,221	9,140	9,104
Air and gas lift wells making water	200	162	69	60	54	22	20	5	5	17	13	21	18
Air and gas lift wells not making water	474	488	472	473	416	386	335	333	303	300	303	314	301
Total air and gas lift wells in field	674	650	541	533	470	408	355	338	308	317	316	335	319
Total wells making water	5,310	5,396	5,459	5,416	5,375	5,408	5,401	5,297	5,259	5,088	4,990	4,898	4,891
Total wells included in report	9,742	9,911	10,120	10,239	10,276	10,479	10,739	10,293	10,405	10,221	10,142	10,092	9,990
	Daily water withdrawals												
Total daily water withdrawals	552,307	589,208	618,866	652,796	652,759	646,477	670,575	659,202	642,683	599,286	543,270	508,955	493,072
Daily average water withdrawal per water well	104.01	109.19	113.37	120.53	121.44	117.97	124.16	124.45	122.21	117.78	108.87	103.91	100.81

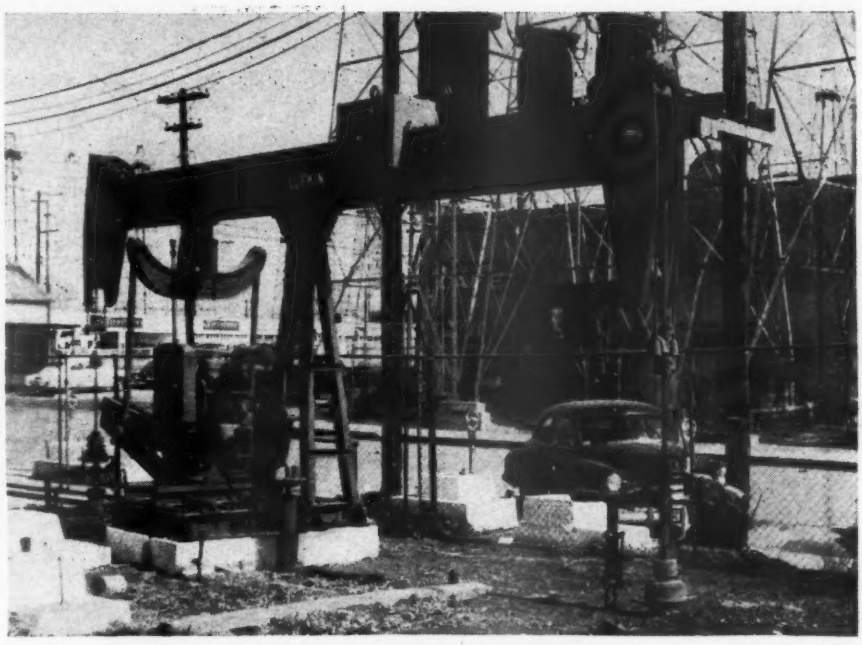
Parish, Louisiana. Gas occurs in the northern part of the field and oil in the southern.

Oil and gas were discovered here in shallow horizons as early as 1924. The Travis Peak limestone, which has thick beds of red shale, was produced restricted flow, at 5,000,000 cu ft in 1939 from 5970 ft by the Arkansas-Louisiana Gas Company. In 1945, the oolitic Pettit with an acid treatment of 15,000 gal was initially produced by the same company with an open flow of 6,500,000 cu ft through perforations at 5650 ft.

In 1946 an oil well with a low GOR was completed in the Travis Peak to the south of the field with an initial production of 54 bbl, 430 gravity.

The producing limits of the field are still undefined, and eight rigs are operating in the vicinity. Successful gas producers have been obtained from several step-outs, but again, due to the variable nature of the pay formation irregular productive localities exist. No doubt, the Pettit, like many lime stone reservoirs, has that inherent characteristic of "hide and seek" permeability zones. If only it were possible to correlate these zones the problem of determining a correct well location would be eliminated, and, consequently, only positive producers would be drilled. It is apparent that up to the present no means of accurately prognosticating permeability streaks has been devised. One can but hope that a well will penetrate a large, or even small fissure, or failing this, then an acid treatment will enable the well bore to have communication with some permeable portion of the limestone.

Because the Waskom and the Woodlawn fields are progressively expanding along the same axis, some are of the opinion that both probably have a common reservoir.



One pumping beam serves two wells on the Laird Moses lease in the East Texas field. The well site is situated right in the town of Kilgore.

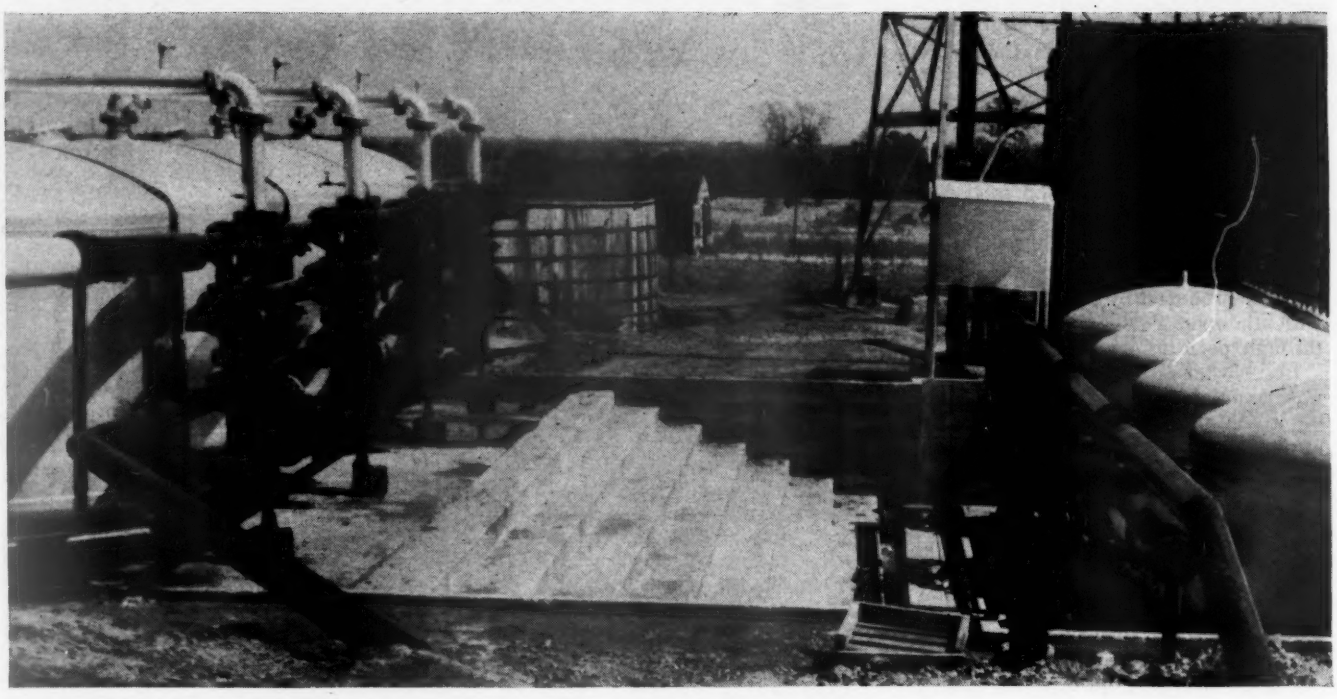
In Panola County the circle cuts the Carthage gas field. Activities here date back to 1930 and the total proved acres (cumulative) is 240,000. The main producing zone is the Lower Pettit; there is an active water drive present. In the southeast part of the field oil has been produced. Skelly Oil Company on the Holiday lease completed an oil well in early 1952 with 140 bbl allowable, 430 gravity, which was produced from the Lower Pettit at 6174 ft.

The presence of CO_2 in some of the Carthage gas wells has been causing a corrosion problem and the application of inhibitors has been necessitated. A recent gas well in the Lower Pettit had an open flow potential of over 8,000,000 cu ft per day.

Willow Springs, Gregg County, completes the circle of the first area. The field has more than 6000 proved surface acres and the Humble-Gulf discovery well was produced at 7000 ft from the Pettit lime. The Rodessa was first produced by Horton and Dickson in 1941 and the formation now has over 6000 proved acres. Difficulty is experienced in correlating the formation as it is one of lenticular deposition. A thin gas column exists and no water has been produced as yet, and the producing limits are unknown.

A gas play in East Texas is in progress. A semi-wildcat being drilled to 8000 ft in Gregg County, Texas, by the Delta Drilling Company for British American.

A salt water injection well in the East Texas field. The injection string is plasticized. The upper flow line is for pumping requirements, and the lower one is utilized when gravity flow is possible. This Payne No. 1 well alone has injected almost 36,000,000 bbl of water since January, 1943.



The injected salt water for the East Texas field is specially treated. One process is filtering. A battery of 8 National Tank Company pressure filters at the Payne salt water treating plant near Kilgore. Each filter is 8 ft diam, 5 ft high (in the shell), and has a capacity of 5000 bbl water per day.

A Rodessa completion has yielded 21,000,000 cu ft per day open flow. Drilling activity in this part of the area is continuing at a good rate; six producers in six months have been accomplished.

In March, 1952, near Kilgore the Delta Drilling Company was drilling a semi-wildcat for British-American, and if the well becomes a successful gas producer it can be considered as an extension to the Willow Springs field. The projected depth of the well is 8000 ft and gas is anticipated from the Pettit limestone in the Travis Peak group. The 9⅝-in. surface casing was set at 1000 ft, a 5½-in producing string is scheduled, and completion will be by perforating followed by an acid treatment. The drilling of this type well does not present any serious mud problems and a clay base type is used.

An important wildcat on the W. T. Cook lease, east of Willow Springs, successfully produced on an open flow potential 22,000,000 cu ft per day from the Lower Pettit limestone. This has accentuated the possibilities of a widespread producing limestone.

Second Area

The second area, which covers Wood County, Texas, has oil possibilities. Production is sought from the Sub-Clarksville and Woodbine sands, and drilling activity is increasing in an attempt to locate these pays.

The Sub-Clarksville is generally a medium grained sand with permeability from 400 to 1400 millidarcies. The entire area is considerably faulted and the geology is thereby somewhat complex.

The Woodbine oil is 20 deg gravity, asphaltic, and that from the Sub-Clarksville is a mixed type with a 25 deg average gravity. Some of the production in this area has been encouraging. For example, the F. R. Jackson et al 1A well on the F. A. Harper lease had a 55 bbl allowable, 39 deg gravity from 5420 ft in the Woodbine sand. At Midway Lake, A. W. Baker lease, a current producing well has a 73 bbl allowable, 43 gravity from Sub-Clarksville at 4473 ft.

It is too early to attempt to forecast the future oil potentialities in this second area, but an intensive drilling program is in preparation, which could be considered, at least, a good outward sign.

The oil and gas possibilities of both the areas described are far from being actually assessed to date, and many more wells need to be drilled before a decision can be reached: Take for instance the East Texas field. Only a few wells, a mere half dozen, have been drilled deeper than 7000 ft. But who knows that oil does not lie beneath the fabulous and stratigraphically trapped Woodbine sand.

It was said that oil could not be found in the East Texas field because of insufficient closure. And when the field did produce, the occurrence was explained away as one of coincidence. The drill should prove beyond all doubt before it can be safely said that oil does, or does not, lie in any particular area. The drills will still have to rotate in the East Texas field, and, in the areas beyond.

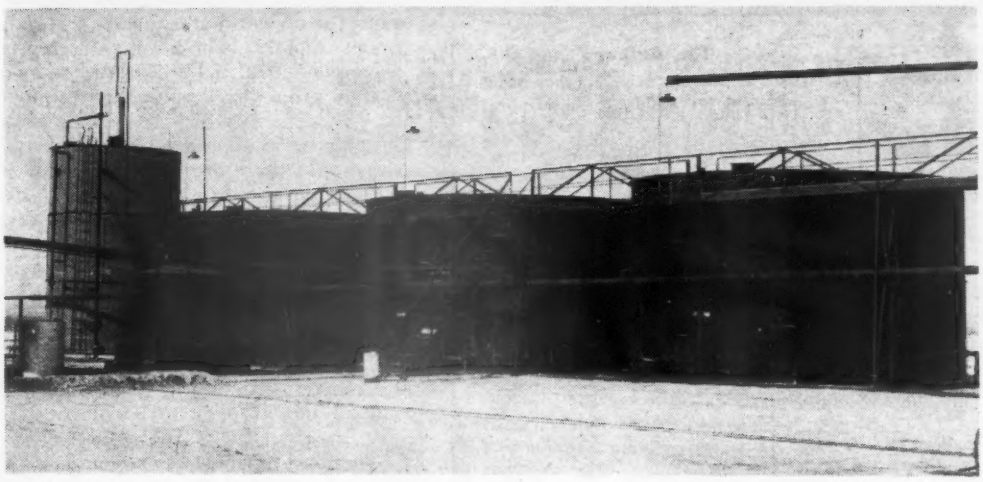
Costs

In the East Texas area the cost to drill and complete, including surface equipment, is $35,000 for a 4000-5000 ft well with an additional $5000 when the well is put on the pump (Table 4). In contrast to this, an 8000 ft well costs $78,000 with an extra $8000 for pumping equipment when it is required. The actual drilling cost to 5000 ft is $15,000, and to penetrate 8000 ft costs at least $45,000. If the Travis Peak formation is found at this lower depth then the expenditure is greater.

From these cost figures can be seen the greater financial risk involved when an increase in depth is anticipated. For example, drilling to 4000-5000 ft costs $3.30 per ft, whereas to 8000 ft it is almost twice this amount, that is, $5.60 per ft. To drill and complete at 5000 ft takes $7.80 per ft, and when on the pump the figure increases to $8.90 per ft. And for 8000 ft the cost for drilling and completing, becomes $9.20 per ft, and $10.72 per ft after the pump is installed. In other words, when the depth is doubled the drilling cost per foot is doubled; the overall completion cost per foot is at least 1¼ times as great, and if production is from the Travis Peak formation at 8000 ft the overall cost per foot figure will be considerably increased. An oil operator has to consider these cost facts before drilling a well in the East Texas oil-gas area. * * *

TABLE 4. Well costs—East Texas area.

Depth ft	To drill	To drill and complete	Pump equipment	Total well cost	To drill per ft	To drill and complete per ft	Overall cost per ft
4000-5000	$15,000	$35,000	$5,000	$40,000	$3.30	$7.80	$8.90
8000	$45,000	$78,000	$8,000	$86,000	$5.60	$9.20	$10.70



Chemical dehydrating plant located at McKittrick, California. This photo shows the wash tank and stock tanks. The crude treated is 13 API gravity.

EXCLUSIVE

The Heat Factor in Treating Heavier California Crude Oil Emulsions

LOUIS T. MONSON*

California oil fields commonly produce oils of lower API gravity and higher viscosity, and waters of lower specific gravity than do other areas. These characteristics do, as would be expected from Stokes' Law, make the dehydration of California crudes generally more difficult. This increased difficulty has been reflected in higher pipeline specification allowables for water and emulsion contents of such crudes.

Application of heat increases the gravity differential between oil and water, and decreases the oil viscosity. The latter has been shown to be the much more important effect. Several striking examples show the savings frequently to be made by employment of less heat and more chemical in the treatment of heavy California crudes, in the saving of light ends and achievement of cleaner oil.

Crude oils produced in California over the years have had generally higher viscosities and generally lower API gravities than oils produced elsewhere in the United States. California oil-field waters are usually of lower specific gravities than those of other oil-producing areas. These characteristics have introduced a number of problems in the resolution of California crude oil emulsions, which have been met by development of treating practices individually suited to that area.

*Chief chemist, Treolite Company of California.

For example, California crude oil emulsions have, on average, been more refractory and stable than those from other areas. The stability and resistance to resolution is reflected in the pipe line specifications in California. Whereas in other domestic fields pipe line specifications range downward from about 1 per cent to as low as 0.1 per cent, California specifications generally permit shipment of crudes containing as much as 3 per cent of emulsion, water, and sediment. If California crudes were as susceptible to treatment as non-California crudes, pipe line limits should be substantially the same inside and outside that state.

This observed greater stability of California crude oil emulsions arises in part from the presence of larger proportions of "black" substances in these crudes. These asphaltic and bituminous constituents have long been blamed for acting as the emulsifying agents that stabilize crude oil emulsions. The heavier, blacker California crudes have consequently emulsified more readily, and the emulsions produced have resisted resolution more stubbornly than is generally the case in other areas.

The high stability of California emulsions arises in part from the appreciably greater average viscosity of California crudes. Water particles of even relatively large size settle only slowly through a viscous oil. It has been shown that the viscosity of a crude oil emulsion may be several times as great as that of the oil from which it is made. Consequently, in viscous oils, the "sludging" of any emulsion present takes place very slowly. Similarly, water particles large enough to be classed as "free water" in a centrifuge test will settle only slowly through a viscous oil or its emulsion.

To demonstrate this point in practical terms, samples may be taken periodically from the top, middle, and bottom levels of a container filled with heavy (about 15 API) Santa Maria Valley crude, and centrifuged in the conventional manner. The results show there is little difference in emulsion or water content at such different levels, even if sampling be repeated at intervals for a period of weeks. Similarly, successive samples taken from any single level over a period of time will show substantially no differences in emulsion and water content. Sludging of emulsion is negligible in such oils.

All of the foregoing statements are based on observations that are well-known in a general qualitative way. Some may hold that nothing need or can be added to such elementary knowledge at this late date. The published literature has never considered such factors in detail, however, and the record should therefore be expanded as to the relative importance of some of them. To do so will be to furnish the foundation for subsequent quantitative examination of the problem of treating—and especially, of settling water particles from—

California crude oil emulsions.

The following discussion will therefore not give practical operating information on the treatment of California crudes. It will give concrete examples illustrating the relative magnitudes of some of the mathematical values encountered in a consideration of the fundamentals of treating practices. It is intended to emphasize the relative importance of several factors that lie at the heart of the demulsification operation, especially as applied to the heavier California crudes, whose demulsification is usually difficult and frequently slow.

If Stokes' Law is applied to crude oil emulsions, one can predict that water particles will settle at rates directly proportional to the squares of their diameters and inversely proportional to the viscosity of the oil through which they are settling. Stated another way, if one water particle has twice the diameter of a second particle, it will settle four times as fast as the second particle. If one oil is two-thirds as viscous as a second oil, water particles of a given size will fall through the first oil 50 per cent faster than through the second.

Another element in Stokes' Law is the difference in specific gravity between the falling sphere and the liquid through which it falls. In crude-oil-emulsion parlance this is commonly called the "gravity differential." California oil-well waters are generally relatively fresh and soft. Some of the heaviest, blackest crudes are produced with comparatively non-saline waters.

For example, a sample of oil-well water from Coalinga was analyzed many years ago, along with a sample of Los Angeles city water taken that same day. The oil-well water was not even as hard as the city water; and it contained only 7500 ppm (parts-per-million) total solids, mostly sodium chloride.

Since that time, some 700 samples of oil-well waters, taken from some 60 different California oil-producing areas, have been analyzed for chloride salinity. (As chloride is the commonest anion in such waters, and sodium chloride is the commonest salt, determination of chloride and calculation to sodium chloride gives a conservative approximation of the total-solids content of an oil-field water. From it, an estimate may be made of the specific gravity of the water).

None of these samples showed a chloride salinity greater than about 35,000 ppm. The salinity exceeded 30,000 ppm in the samples from only 9 of these areas. The samples from about half of the areas showed salinities less than 20,000 ppm; while the Kern Front samples showed salinities of only 300 ppm. A salinity of 35,000 ppm is equivalent to a specific gravity of about 1.02; a salinity of 20,000 ppm is equivalent to a specific gravity of about 1.01; and of course a salinity of only 300 ppm means the water is substantially fresh and has a specific gravity of about 1.00.

The settling rate of a water particle through crude oil depends directly on the difference in specific gravity between the water and the oil, as above stated.

The Author

Louis T. Monson is chief chemist of Tretolite Company of California. He was graduated from Washington University, St. Louis, with a BS in chemical engineering and an MS in chemistry. Upon receiving the latter degree in 1926, he entered the employ of William S. Barnickel and Company, St. Louis, predecessor company to The Tretolite Company. He was transferred to the latter's California affiliate in 1931 and has been employed there to date. He is the inventor named in some 35 U. S. patents, and has written a number of technical papers, principally related to the demulsification of crude oil.

It is at once apparent that, if the oil is of low specific gravity (high API gravity) or the water is of high specific gravity, the gravity differential between the two liquids is relatively large. Conversely, if the oil's specific gravity is high (low API gravity) or the water's specific gravity is low, the gravity differential is relatively small.

When the oil is of low API gravity and the water is of low specific gravity, the gravity differential is obviously at a minimum. Such situations are of especial significance here, for they occur in some California oil fields. For example, fields like Cat Canyon, Gato Ridge, Kern Front, and Richfield all produce low-gravity crude, of about 15° API or less The waters they produce usually show chloride salinities less than 20,000 ppm —and even as low as 300 ppm, as in the case of Kern Front waters, just mentioned. Emulsions from such fields are often difficult to separate because of the gravity differential alone, and disregarding other unfavorable factors such as the high viscosities exhibited by the oils.

To illustrate the influence of gravity differentials: Assume the crude to have a specific gravity of 0.966 (15 API). Assume the oil-well water to have a specific gravity of 1.002. The gravity differential would be 0.036. If the water were moderately saline, its specific gravity might be 1.02. The gravity differential would then be 0.054. Water drops of constant size would therefore settle from this 15 API crude at a rate 50 per cent faster if their specific gravity were 1.02 than if it were 1.002. If the water were even more saline and had a specific gravity of 1.038, a not exceptional figure for oil-field waters from some states, the gravity differential would be 0.072. Such water would settle twice as fast from 15 API crude as would 1.002 water, assuming the droplets to be of constant size.

The most obvious way to increase the gravity differential between crude oil and water is to apply heat. Heat is useful in enlarging the gap between the oil and water gravities because oil expands more rapidly than water. For example, an oil that has a gravity of 15 API at 60 F (sp. gr., 0.9659) has a gravity of 21 API (sp. gr. 0.9279) at 170 F. Pure water has a specific gravity of 0.9990 at 60 F and 0.9704 at 170 F. Therefore, when the oil is heated from 60 to 170 deg, its specific gravity changes by 0.0380; while the water changes by 0.0286 specific gravity units.

In the foregoing example, the gravity differential at 60 F is 0.0331 whereas, at 170, it is 0.0425, or 28 per cent greater.

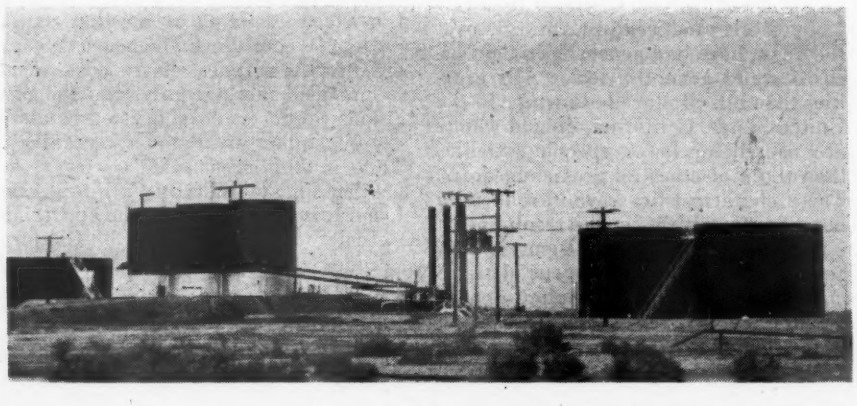
If the water were an oil field water of specific gravity 1.02 at 60 deg, a not unusual figure, the gravity differential at 60 deg would have been 0.0541; and at 170 deg it would have been about 0.0635, or about 17 per cent greater.

From these examples, it may be stated that the effect on the gravity differential resulting from the application of heat is greater, percentage-wise, as the water becomes fresher, i.e., approaches pure water in composition.

It is also apparent that the effect of heat in increasing gravity differential is not a great one, over the ordinarily-applied temperature range.

A much more important effect resulting from the application of heat is the reduction of viscosity of the crude. A 15 API crude may, for example, have

Heavy oil treating plant at South Belridge, California. This plant chemically dehydrates about 4000 bbl per day of 13 API oil.



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a vis of about 3000 centipoises at 60 deg, whereas at 170 deg its viscosity would be about 20 centipoises. The reduction in viscosity is therefore to a level less than 1 per cent of the original value. Emulsions have viscosities higher than that of the oil they contain, as is well-known.*

The reduction in viscosity of an emulsion on heating may not be in the same ratio as in the above example; but it will be of the same order of magnitude. The degree of change of viscosity with heat is obviously many times as great as the change in gravity differential; and the effect of heat is therefore principally on the viscosity rather than on the gravity differential.

Where the emulsified crude is as heavy and viscous as the lower-gravity California crudes, considerations like those just discussed are of especial importance. However, development of better commercial chemical demulsifiers and treating practices has resulted in constantly improving levels of performance. Such improved reagents and procedures tend to reduce the importance of high viscosities and low gravity differentials, and hence, of heat. Even the heavier, blacker crudes are being treated under conditions and at costs that would have been considered impossible 20 years ago. As a consequence, fewer tank bottoms are being accumulated. With more complete emulsion resolution, the residues of unresolved emulsion are smaller and accumulate more slowly—or in some cases actually resolve on longer standing, as in tank farms.

This is not to say that no tank bottoms whatever are accumulating in California. Also, there are in existence tank bottoms representing the accumulation of past years. For example, one Los Angeles Basin producing company not long ago recovered from an accumulation of tank bottoms at its tank farm some 35,000 bbl of pipe line oil, worth nearly $68,000. The total cost of recovery, including labor, fuel oil for heating, and chemical demulsifier, was only $5300.

Such returns are obviously most attractive. It must be remembered, however, that some tank bottoms contain large proportions of inorganic sediment. Not only will they respond much less readily to oil-recovery procedures, but their oil contents are lower. Chemical demulsifying agents, however carefully applied, will not miraculously convert drilling mud or formation sand into salable crude. Conversely, the example just recited shows that when properly selected chemical demulsifiers are applied correctly in a properly designed treating plant, much salable oil can be recovered even though the presence of mud and sand makes the cleaning difficult.

Tank bottoms have been mentioned briefly here because their resolution usually involves the use of heat. They commonly contain relatively large proportions of emulsified water, and their viscosities are usually quite high, for this reason. Where sump oils are involved, high viscosities may also be the result of exposure and weathering. In the latter case, rain may have fallen into the sump and the rainwater later become emulsified, in transfer or otherwise. Reduction in gravity differential could thereby have been achieved. These factors have been discussed above.

The preceding discussion has considered the heat factor, and the question of whether its principal effect is on emulsion viscosity or gravity differential.

There is another point involving heat which, although known for years, is still sometimes neglected. It is well-understood that the amount of chemical demulsifier and the level of heat employed (where any heat at all is required) are related. When the amount of chemical used is increased, the heat requirements are reduced, and *vice versa*. Because chemical demulsifier must be purchased and brought to the lease in separate containers, whereas oil or gas for fuel is commonly taken from the producer's own stock, the cost of the latter is frequently discounted. Because of this disregard for fuel costs, there is in many operations a tendency to use more heat, less chemical.

In addition to this sometimes-hidden fuel cost, there is another general disadvantage in the use of excessive heat—the loss of light hydrocarbons or "light ends" even from heavy crudes. This results in a volume loss and a gravity loss, and means the sale of less oil at a lower price per barrel. The following examples offer particularly striking illustrations of the proposition that, on California heavy crudes (as elsewhere), use of a demulsification practice involving more-heat-and-less-chemical may be more costly than using one of less-heat-and-more-chemical.

One operator, producing 3200 bbl of oil a month, varying in gravity from 15.4 to 15.9 API, was using chemical at a rate of 1.2 cents a barrel of net oil recovered, and a treating temperature of 165 F. By increasing his chemical feed to 2.0 cents a barrel, net, he found he could reduce the treating temperature to 145 F. Shipping gravity of the oil was thereby raised to 16.0-16.4 API. As the posted price of 16 API oil was 6 cents per bbl higher than that of 15 deg oil, he gained 6 cents on every barrel sold, under the less-heat-and-more-chemical practice; and he did so at an increased outlay of only 0.8 cents a barrel for chemical. His net gain was therefore 5.2 cents per barrel, neglecting the saving in fuel. The saving was at least $166 a month.

Another operator was shipping 3000 bbl of oil a month, usually at from 11.6 to 11.9 API, with an occasional tank going at 12.0 API. To do so, he was using chemical at a rate of 2.0 cents a bbl of net oil, and a temperature of 180 F. By lowering his treating temperature to 155 F and increasing his chemical feed rate to 3.0 cents per barrel, he was able always to ship the production above 12.0 API. The difference in posted price between 11 and 12 API oil was 10 cents per barrel. His net profit was therefore 9 cents per barrel, again disregarding savings in fuel.

A third operator was shipping 21 API oil by his regular treating procedure. By increasing his chemical feed rate by 1 cent per bbl, and making no other changes, he was able to ship 22 deg oil regularly. The price differential between 21 and 22 deg oil in that field at that time was 10 cents per barrel. The saving was therefore 9 cents per barrel.

Although the foregoing three examples admittedly cover a period when the price differential between successive points in API gravity was high, there has always been a differential of from 2 to 4 cents in those fields. Since no more than 1 cent per barrel additional chemical was used in any of the examples, the more-chemical-and-less-heat operating practice they illustrate would have been profitable at any time in those areas.

The last example, where no heat reduction was involved, illustrates another long-known but commonly neglected point: Sometimes it is possible, by use of slightly more chemical, to reduce the water and emulsion content of a crude sufficiently to reach the next higher gravity bracket. Removal of 1.0 per cent of water from 35 API California crude will result in the recovery of about 0.3 API gravity. For lower-gravity oils the recovery is smaller, of course; but is still often important. For 25 deg oils, the recovery is about 0.2 API; for 20 deg oils, about 0.1 API. There are many operations today that would profit by shipping oil of only 0.2 or 0.3 deg higher than gravity, as the price schedules do not ordinarily include provision for payment for fractional degrees of API gravity.

In summary, California oil fields commonly produce oils of lower API gravity and higher viscosity, and waters of lower specific gravity than do other areas. These characteristics do, as would be expected from Stokes' Law, make the dehydration of California crudes generally more difficult. This increased difficulty has been reflected in higher pipe line specification allowables for water and emulsion contents of such crudes.

Application of heat increases the gravity differential between oil and water, and decreases the oil viscosity. The latter has been shown to be the much more important effect. Several striking examples show the savings frequently to be made by employment of less heat and more chemical in the treatment of heavy California crudes, in the saving of light ends and achievement of cleaner oil. * * *

☆ ☆ ☆

Although the U. S. has only 12 per cent of the world's land area geologically favorable for petroleum, American oil men have discovered about ⅔ of all the oil found in the world to date.

*For example, see Monson, Industrial and Engineering Chemistry, *30* 1287 (1938); Woelflin, Petroleum World, *39*, 34 (1942).

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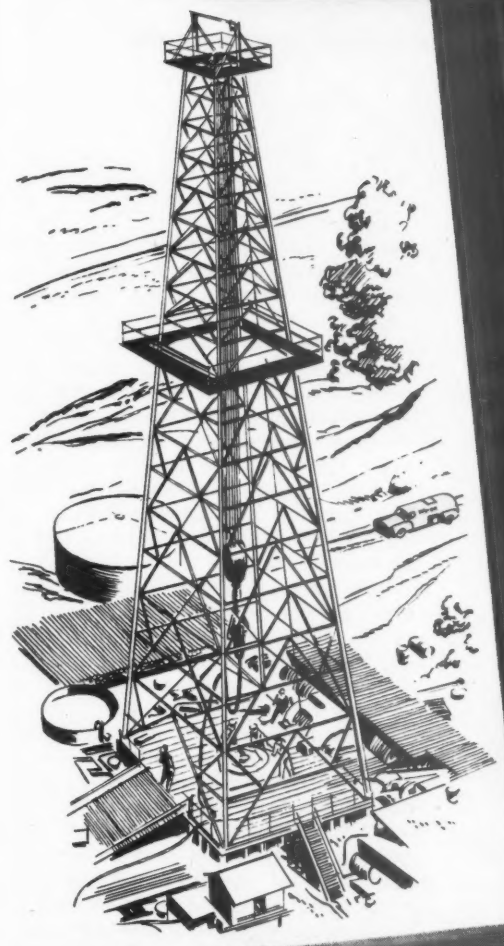

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Where Producing Research Is Headed

To find new reserves and to improve oil and gas recovery, problems are sent to the expanding clinic of the industry—the research department

GERHARD HERZOG

THE tasks entrusted to the producing research laboratories of the oil industry are intimately related to the economy of the oil industry and therefore of our country. Producing research is charged with development methods and with understanding the processes that lead to maximum ultimate recovery, on an economical basis, of the natural petroleum resources. Not only is such a program of over-all interest to our economy, but it also produces a great incentive since any improvement in the solution by a particular company will give it advantages over the rest of the industry. It is not surprising then that the oil companies are taking a great interest in producing research, and that they are willing to invest in short and long term projects. Past experiences have shown to managements that soundly conducted research assures technical and economical progress.

It is not the purpose of this paper to describe in detail the research projects of any one company. We, who are working in this field, are well aware of the general trends that prevail throughout the industry. Great efforts are being made for a better understanding and evaluation of subsurface data. This information is accumulated from measurements on cores which are taken from the well bore or from cuttings which are returned to the surface in the mud stream. We can learn about porosity, permeability, and the fluid content, with respect to both oil and water. These measurements are taken on samples that are infinitesimally small compared to the underground areas in which one is interested. Obviously then one has to be cautious always to remember this fact. This is an observation that cannot be altered even if the technical methods could be improved considerably in accuracy.

For this reason and because of the often excessive cost of coring, more and more emphasis is placed on information obtained from well logging. The well logging tools have in common that they provide data based on averages over much larger samples of the ground. Provided that the logs can be read with a sufficient understanding and accuracy, they without a doubt make available subsurface data that are to be preferred as compared to cores and cuttings. This brings one to the question of the interpretation of well logs.

The Author

Gerhard Herzog is director of research of the producing department of The Texas Company. He was born in Zurich, Switzerland, and received his degree in mechanical engineering and his PhD in physics from the Swiss Institute of Technology. He was elected associate professor of physics at the Swiss Institute in which capacity he served for approximately five years.

Herzog came to the United States in 1938 and was research associate to Dr. A. H. Compton at the University of Chicago, in the field of cosmic rays. He joined the geophysical laboratory staff of Texaco in Houston, Texas, in 1940, and was promoted to his present position in 1947.

Logging devices are in use that measure various qualities of the ground, such as the electrical resistivity, the "self potential," the natural radioactivity, the reaction to neutron bombardment, the determination of the velocity of sound and others. It is interesting to note that none of these methods measure directly those qualities in which the petroleum engineer is interested. He wants to know the porosity, the permeability and the saturations. The various logging devices give values that are influenced by these qualities to various degrees and in various ways. In other words, the logging itself requires a secondary step of interpretation before it can yield the desired data. This step sometimes leaves considerable questions as to its applicability. It is not surprising, therefore, that the research laboratories are spending a considerable amount of effort on this step and their efforts show important results. We are, however, by no means at the end of the road. It becomes more and more evident that combinations of various well logging tools are necessary before clear cut answers can be obtained with respect to the basic questions.

Well logging methods lend themselves to geological studies. Correlation between various logs can be established and thereby geological trends, and sometimes predictions can be made. Here again the use of the log is most important and it can be foreseen that tools that measure additional properties of the ground will be developed to help in geological work.

The research laboratories study patterns for the most successful arrangements of wells and schemes for producing known hydrocarbon reservoirs. In the case of gas condensate fields the arrangement of the wells and the rates of individual wells is of great importance when cycling operations are to be used. Regarding the question of additional recovery through secondary methods, instruments have been developed and studies are made to determine the advantages of one proposed operation method as compared with others. In connection with these studies the information on the pressure, volume, and temperature have to be considered as the characteristics of reservoir fluids are dependent upon these factors. Most of the research laboratories are working on these problems.

Research people feel sure that the management of any one company would be happy if they could propose a scheme whereby only oil would be recovered from the formations whereas the water would be left in the ground. At the present time substantial amounts of energy and considerable costs are being spent for lifting the water to the surface, together with the oil and then for the separation of the two. In addition, there is the problem of disposing of the unwanted water. It would indeed be desirable if this separation could be made in the well, and in the producing formations so as to produce only the oil.

The economy and success of drilling wells is intimately related to the quality of the drilling mud. With the present trend of drilling deeper wells, the mud problem becomes of increasing importance. Properties of drilling muds that

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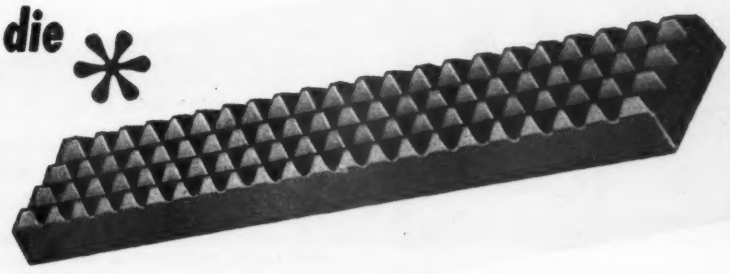

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Where Producing Research Is Headed

To find new reserves and to improve oil and gas recovery, problems are sent to the expanding clinic of the industry—the research department

GERHARD HERZOG

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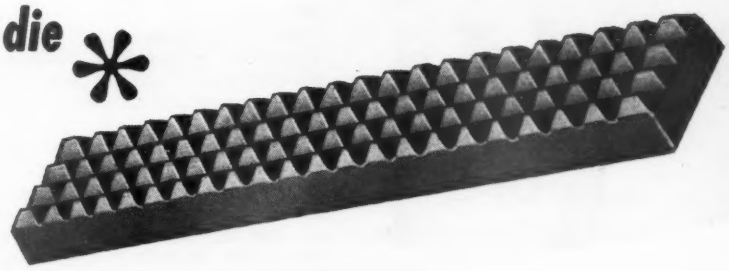

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may be satisfactory for shallow depths have to be modified for use at the temperatures and pressures encountered in deeper holes. The study and development work on drilling muds occupies a prominent place in producing research.

The costly occurrence of "lost circulation" challenges the imagination of every producing researcher. Some concern themselves with development of special materials which are designed to seal the faulty horizon. Others are worried about tools that will indicate at exactly what depth the loss occurs. Finally, efforts are being made to uncover the reason for the occurrence of lost circulation. Only after this question is answered can one hope to approach successfully a solution to the problem.

Another outstanding research program is every major laboratory comprises studies in connection with mitigation of corrosion. It has been indicated that industry in the U. S. loses yearly an amount of six billion dollars due to damage from corrosion. A substantial part of this money is spent by the oil industry. Corrosion is encountered in the tubular goods within the wells and at the surface, and in tanks, etc. Systemic and basic research is being done to develop corrosion inhibitors in the form of chemicals which may be added to the fluids being produced. In other cases surface coatings are studied.

There are of course many more individual projects that could be mentioned and that are worked on in various laboratories. Other projects of a more general nature are handled cooperatively by the industry through the sponsorship of various projects by the API. When one says that the general trend of producing research consists of studying all those problems that possibly could improve the recovery of known reservoirs or the detection of new hydrocarbon-bearing formations, one expresses the over-all trend and task of producing research. * * *

Drilling Mud Products Are Now in Production

Two products designed for treatment of oil well drilling muds will be in full-scale commercial production within the next two months at the Columbia-Southern Chemical Corporation at its Corpus Christi, Texas plant. E. T. Asplundh, president, has announced that the products, Hydrotan and Hydrocarb, have been developed at the firm's research and development department at Corpus Christi.

Mass production of Hydrocarb will relieve U. S. drilling operators of dependence upon Argentine produced quebracho, heretofore an essential material to oil well drillers, Asplundh reported. Hydrotan controls the viscosity of drilling mud and by being a colloid adds other desirable properties in the process. It is a dry product packaged in paper sacks for use with drilling mud on the drilling side.

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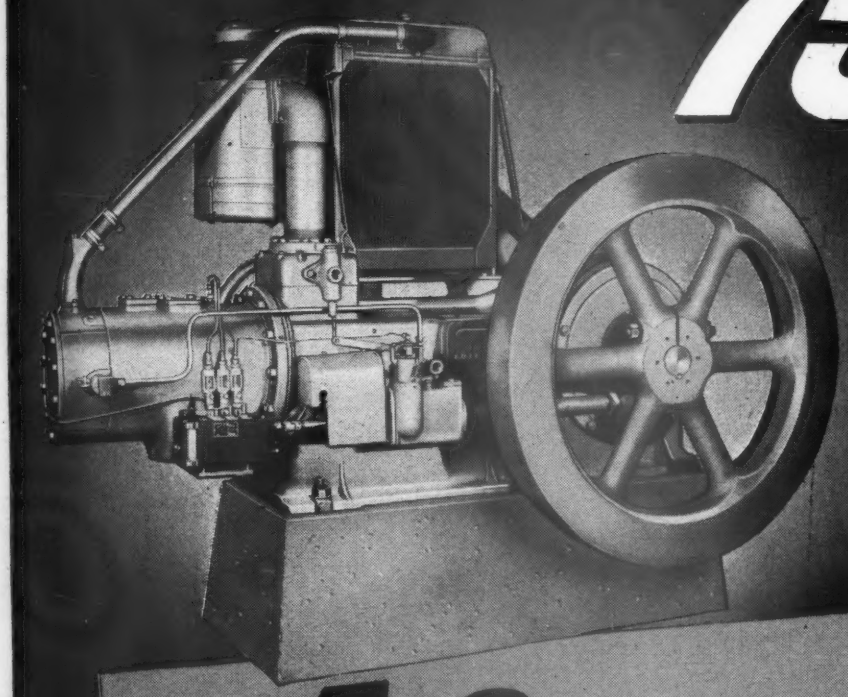

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Several years ago when the accelerated search for new reserves led oil companies into the closely populated suburbs of Los Angeles, California, operators encountered stiff resistance to residential drilling among many home owners.

More than one property owner recalled the wide-open days of the earlier Santa Fe Springs and Signal Hill fields, when oil development meant noisy machinery, blowouts, and unsightly sump holes.

Today, however, as a result of constant engineering and research, soundproof drilling has become a reality in California, and it is now possible to carry out the entire development of a field without disturbing residents.

The Sansinena field at La Habra Heights is in a beautiful residential district about an hour's drive from Los Angeles' civic center, and here soundproof drilling is practised.

Situated on the south side of gently rolling hills, La Habra Heights is one of the most attractive areas in Southern California. Beautiful ranch style homes on 2 to 10 acre parcels nestle among the citrus and avocado groves planted on the slopes of the green hills.

A visitor to La Habra Heights would be hard pressed to find the wells that have been drilled there—or, for that matter, the ones that are being drilled there now—for the wells have been hidden in canyons, and all drilling and pumping operations are so nearly soundless that they are inaudible from a distance of 50 ft.

Well sites deliberately have been chosen in narrow canyons, too steep and arid to cultivate, so that the canyon will help screen the operations from sight. Locations are so selected that a maximum number of wells may be whipstocked from one island to tap the field's resources. As many as 11 wells have been

Looking over the log at Universal's well in the Sansinena field are: George Coffee, Universal's drilling superintendent; G. S. Follansbee, Jr., vice president of Universal, and Lyle Curtis, orange grower, on whose property the Universal well is being drilled.

WATERFLOOD

WITH GUIBERSON'S *type* 'WF'

HOLD DOWN PACKER WITH AUTOMATIC LATCH

Type "WF" Hold Down Packer with Automatic Latch

The Type "WF" hold down packer is a low cost tension packer designed especially for water-flooding, salt water disposal and similar projects. It may also be used for injecting fluids under moderate pressures into the formation below the packer and for other operations requiring tubing pressure in excess of pressure in the annulus.

The packing element on the "WF" is a long sleeve type with sixteen inches of exposed soft rubber that will effectively seal even a rough and pitted casing wall. It will not vulcanize to the casing. Design and construction is such that the same packer will pack-off in a wide range of casing weights; an advantage which, coupled with low initial cost, makes this packer an exceedingly economical investment.

The "WF" has the easy-run, easy-set, easy-pull characteristics of all Guiberson packers. Ample fluid by-pass eliminates down swabbing and assures easy run-in without the use of a valve. Friction springs provide necessary back-ups for the latch mechanism which features an all-metal latching dog with corrosion-resistant coil springs. An anti-lock device assures dependable latch release. Downward movement of tubing in relatch operation automatically latches slips out of engagement with head, freeing packer immediately for removal or resetting. For positive pack-off at lowest cost, use the "WF" in any recommended application.

THE

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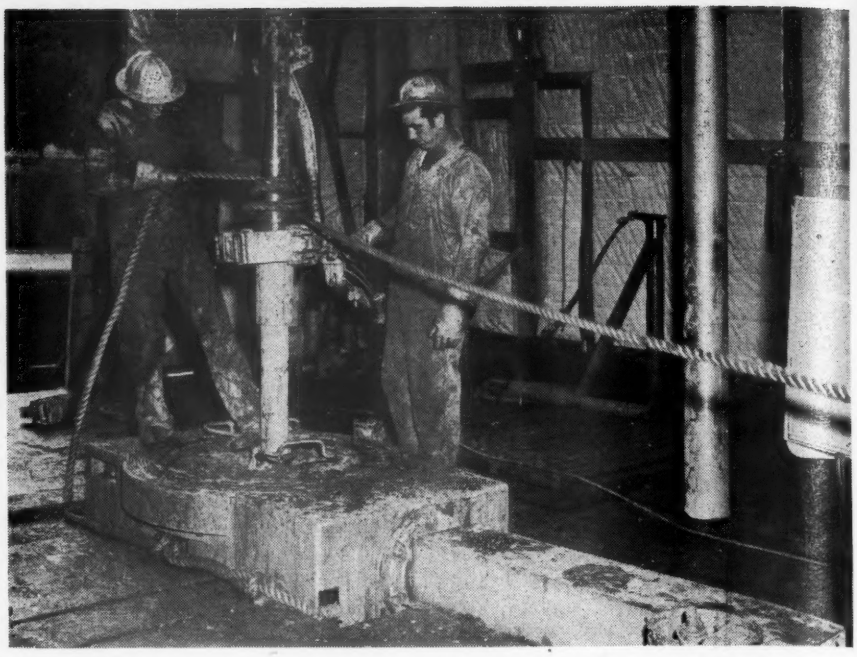
whipstocked from one small island in the Sansinena field.

Typical of soundproof drilling operations in the area is Universal Consolidated Oil Company's Curtis No. 1 on Sec. 31, 2S-10W.

Approximately $30,000 was spent by the operator in preparations preliminary to spudding in the Curtis well. Average cost of such preliminary preparations elsewhere in the California oil fields would have been about $5000. Contract for the drilling work was awarded to Gene Reid Drilling, Inc., of Bakersfield, and a 136-ft derrick, drawworks with twin diesels, and other rotary equipment were moved in. A rig-up time of six days was required on the Curtis well as compared with an average of 16 hr for the same rotary outfit in other fields. After the drilling rig was moved in, the whole works, derrick and all, was covered with a soundproofing material in order to completely muffle all noise of the drilling operation.

Soundproofing material consisted of two layers of vinyl-coated glass cloth with one-inch sheet fibre glass filling, especially heat-processed and quilted. Laps of the fire-resistant, washable soundproofing panels were securely fastened with three-inch safety pins. In addition, the laps were also wired as a safety measure. Rig-builders spent four days covering the derrick and rotary equipment with the soundproofing material.

Colored green on the outside to blend with the landscape, the soundproofing is bright yellow inside, bringing around-the-clock daylight operating convenience and safety for the drilling crew. Orange and white strips are alternated at the top of the derrick as a warning to low-flying aircraft.

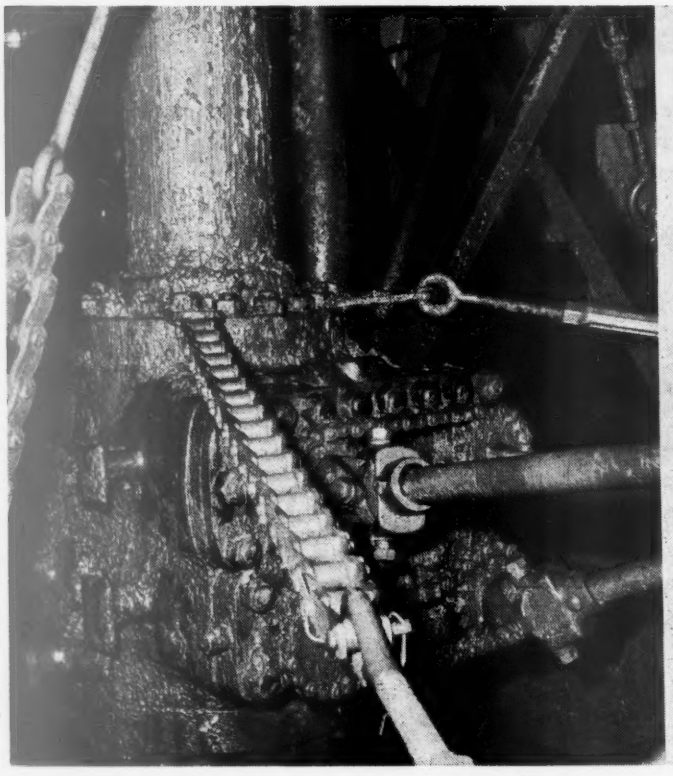


Use of a shaft-driven rotary table cuts down noise inherent in the chain-driven type at Universal's soundproof Curtis No. 1 in California's Sansinena field.

Other features of the operation included use of a shaft-driven rotary table to cut down the noise of the chain-driven type, rubber kelly bushings, and connection of inside exhausts with two outside master mufflers through flexed tubing. The original cost of the rubber kelly bushings was almost 20 per cent less than the conventional type bushing. Operating life of the rubber bushings, however, has proved to be considerably shorter than that of the conventional type. Outside master mufflers were especially built to avoid any back pressure.

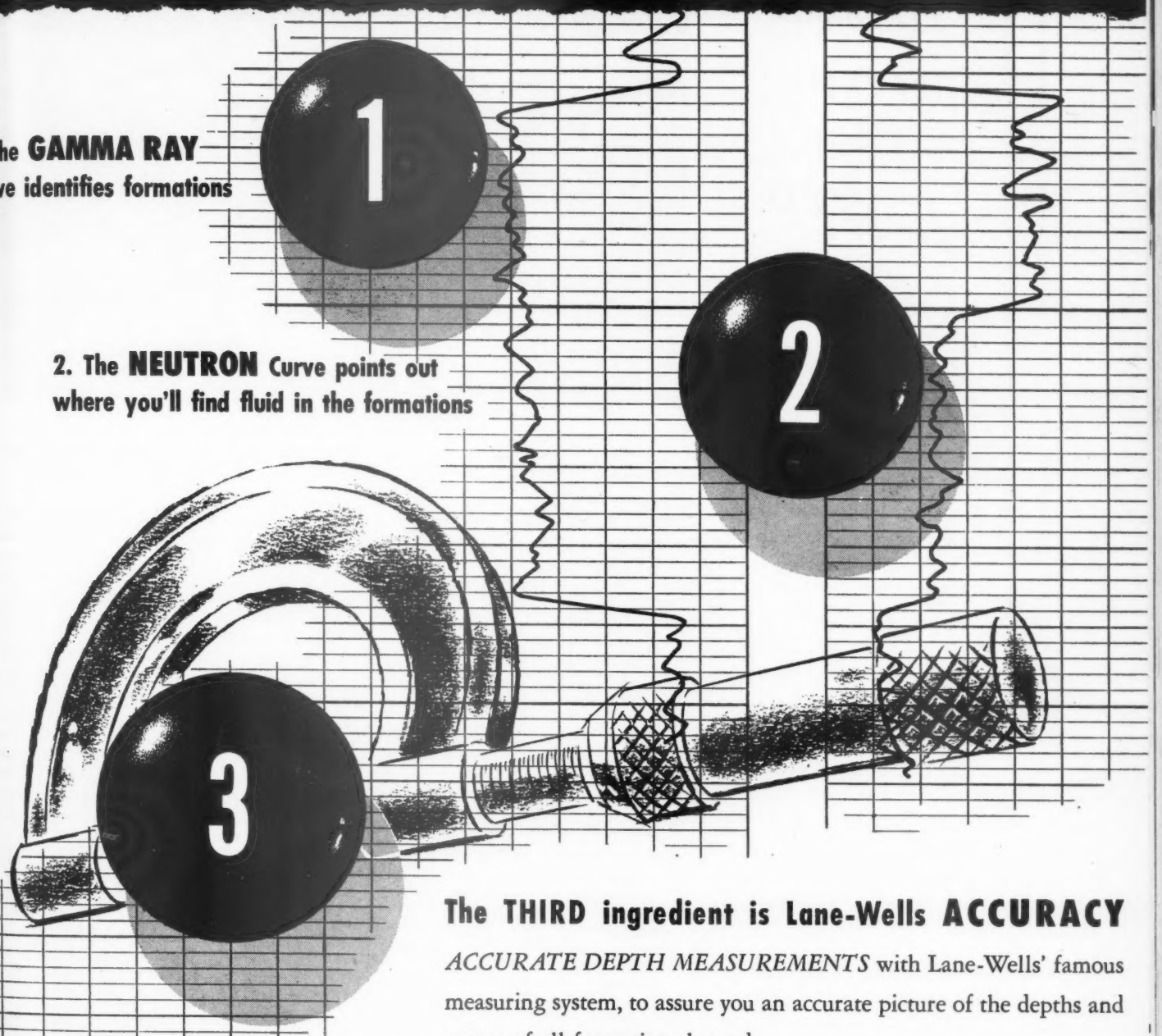
Operations were set up at the Curtis well so that no fluid would be run out on the ground. No sumphole was graded

A double Shaffer head is insurance against blowouts at Curtis No. 1.



Rubber kelly bushing eliminates much drilling noise.

It's the THIRD Ingredient that Pinpoints the Picture



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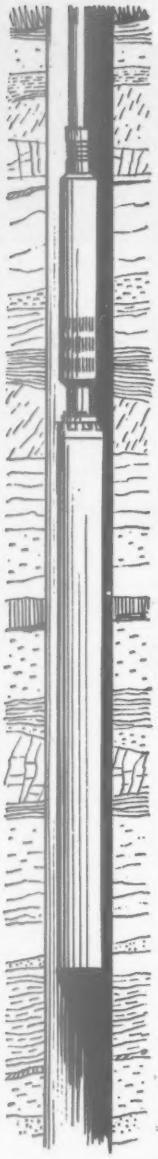


THE BEST WAY TO *LOWER* OPERATING COSTS.... *LOWER* A **REDA** PUMP INTO YOUR WELL

With continually rising labor and investment costs, economy of operation is of paramount importance to operations producing wells with increasing oil-water ratios.

Reda pumps are given consideration as original or replacement equipment because of their known performance in producing fluid at a *lower* cost per barrel, and thus often extending the ultimate economic life of wells.

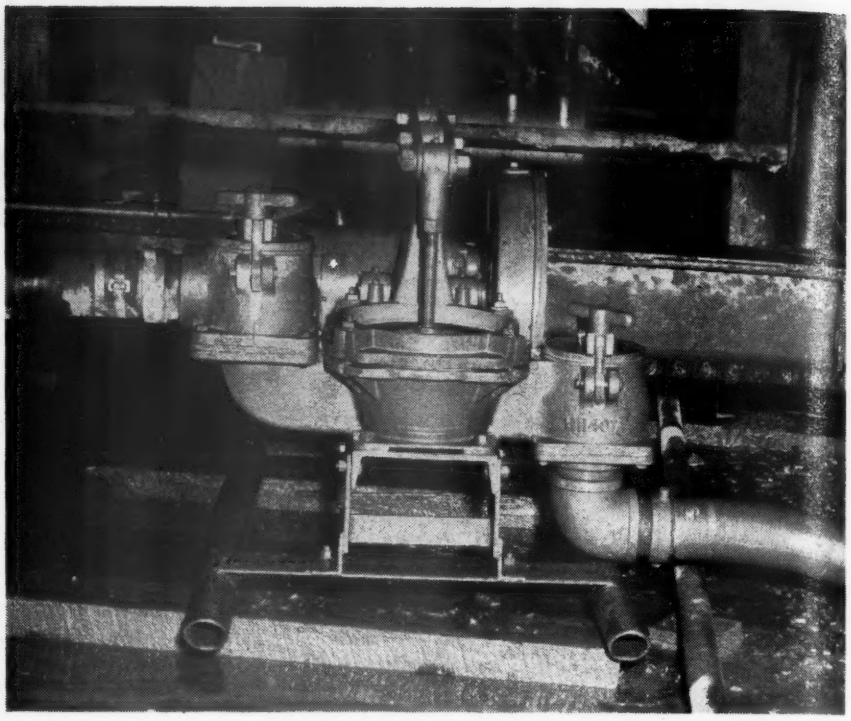
Improved engineering and design have increased operating life. Increased operating life means *lower* labor cost per barrel, *lower* investment cost per barrel, *lower* maintenance cost per barrel, *lower cost per barrel produced.*

REDA

PUMP COMPANY

■

BARTLESVILLE, OKLAHOMA



Waste is sucked from the cellar by a 4-in. diaphragm pump, which operates on the same principle as an automobile's fuel pump.

on the location. A square, 80-bbl tank was set up to serve as a sumphole for shaker diggings. Two mud tanks, a 250-bbl tank for clean mud and a square, 200-bbl tank for waste mud, were installed. A 4-in. diaphragm-type pump was employed to suck waste out of the cellar, operating on the same principle as the fuel pump on an automobile. Vacuum trucks were hired to haul away all waste.

Initial wells when drilled in the Sansinena field were put on the pump and were completely soundproofed. Free pumps have been installed on the more recent wells. In addition to being soundless, the free pumps offer the advantage of being hidden from sight, for they have been installed in covered cellars. Such pumps also obviate the need for pulling units to change the bottom hole pump—the job can be done hydraulically.

Power units, with prime movers heavily muffled, have been enclosed in sheet iron buildings painted with a special camouflaging mixture blend with the canyon walls. When landscaping is carried to completion, the sites will closely resemble small, hidden parks.

It is interesting to note that costly concessions to home owners in the matter of soundproof drilling operations have been dictated more by the oil companies' acceptance of civic responsibility rather than by legal considerations.

Though soundproofing adds thousands of dollars to the cost of drilling and production operations, development of fields such as the Sansinena field is still a profitable operation. An average Sansinena well pumps 21-23 deg gravity crude oil at 150-250 bbl per day rate from about 3800 ft. Production is uniform and sustained, with reservoir studies indicating that the field should prove productive for many years to come.

Another pay-off, less tangible, perhaps, than the financial rewards of successful field development, but no less important, is the good will created by the operating companies. Consideration of the rights of home owners results in an understanding relationship between the oil companies and the residents that makes life in such areas as La Habra Heights very pleasant for both. * * *

Rotary Torque Indicator Saves Drilling Costs

Trouble had been experienced with bit cones becoming detached when drilling in West Texas. Consequently, fishing jobs were necessary with the attendant loss of drilling time and additional expense.

The cause of cones breaking off was due to the fact that a cone would lock, and by additional rotation of the bit itself the jammed cone would shear-off. More often than not any indication of what had happened down the hole was not immediately apparent. A fishing job was the result.

A torque indicator will show when a cone jams, as the driller can see at once on the gage the sudden increase in the torque reading. The bit is then pulled and a fishing job has been avoided.

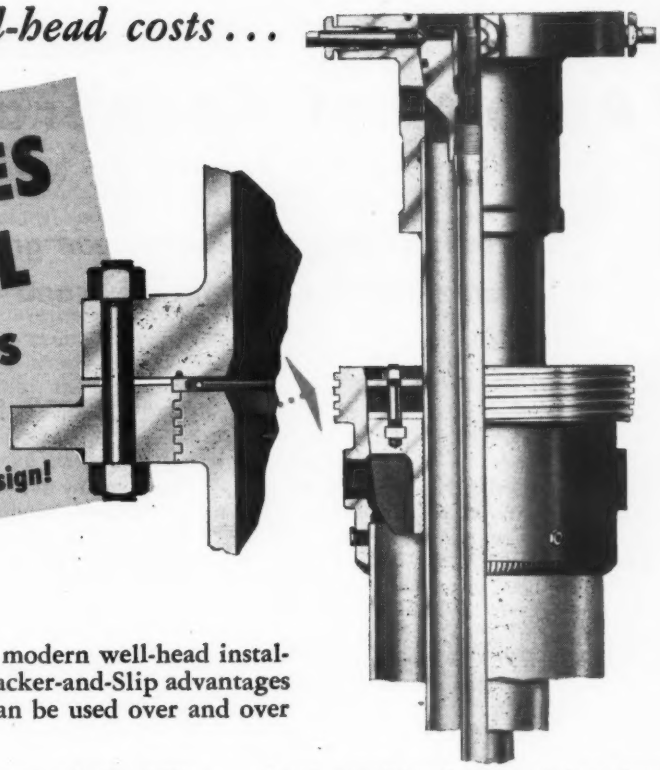
One company in a West Texas area spent on an average of $10,000 per well on recovering lost bit cones before the rotary torque indicator* was included as an "eye" for the driller. Since then, the cost charge against "fishing for cones" has been zero.

*Martin-Decker Hydro-Mech torque gage.

Another Baash-Ross saving in well-head costs . . .

USE THE SAME FLANGES ON WELL AFTER WELL with Baash-Ross 'DF' Heads

. . . plus added advantages of unitized packer-and-slip design!



Here's another important Baash-Ross saving in modern well-head installations . . . equipment that combines the latest Unitized-Packer-and-Slip advantages with the added economy of Demountable Flanges that can be used over and over again, thus saving substantially on well head costs.

Here's how it works...

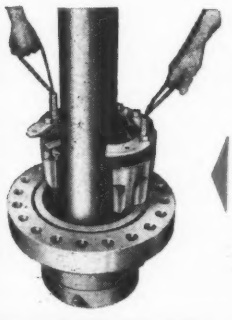
As illustrated above, the flanges on Baash-Ross "DF" Heads are attached to the body with non-binding square threads located *outside* of the pressure pack-off area.

With the flanges attached, the Heads are installed and packed off in the normal way during drilling operations so that conventional gates, preventers and other drilling equipment can be used. A unique Seal Ring, having important advantages over standard ring-groove packing, provides a pressure-tight seal between the flanges.

After drilling is completed and pressure control equipment removed, the demountable flange is unscrewed from the body of the Head—an operation simplified by the easy make-and-break properties of the square thread—permitting the flange, bolts and seal ring to be salvaged for repeated use on additional wells.

Because the multiple-drilled flanges and bolts represent a substantial portion of the cost of a complete well head assembly, important savings are made by salvaging these parts—and the saving continues to increase with each additional well on which they are used!

But demountable flanges are only part of the savings . . .



In addition to being able to salvage the flanges, "UPS-DF" Heads also have another important advantage . . . . a **Unitized Packing-and-Slip** design in which both the slip segments and the packing element are unitized into a single compact assembly that simply *w-r-a-p-s* around the casing, then is locked in place by inserting *one* bolt.

As the weight of the casing is placed on the slips they automatically equalize themselves within the bowl to assure exact centering of the casing and a uniform grip around the *entire circumference* of the pipe. After the slips are seated, a few quick turns of a wrench expands the packing element for a pressure-tight seal. *It's simple, quick, positive!*

Six Important Advantages

By combining Demountable Flanges with the Unitized Packer-and-Slip construction, "UPS-DF" Heads make possible SIX vital advantages in modern well head operations . . .

1. **Costly Flange Portion** can be used over and over again.
2. **Unitized Packer and Slips** eliminate threads, grooves or other packer retaining devices, permitting maximum compactness.
3. **Elimination of Threads** and grooves provides a smooth bowl with nothing to become damaged during drilling operations—no need for protective sleeves or other complications.
4. **Unitized Slip Segments** are locked together for a perfect "set" every time. No risk of crimping the casing or of an unequal grip that may fail in service.
5. **Slips are Set** and packing tightened without stripping and without first cutting the casing.
6. **The Unique B-R Weld-Test Feature,** so popular with leading operators, permits pressure tightness of both casing welds to be tested simultaneously with a gauge and hand pump as part of the installation procedure (or any time later). Imperfect welds can be corrected before welder leaves the rig—any subsequent leaks can be quickly repaired by injecting plastic pack material. Provides leak protection throughout life of the well.

Baash-Ross "UPS-DF" Heads are available in a complete range of sizes for use on low and medium-pressure wells . . . for either threading or welding to the casing . . . with and without Bases . . . and for use with over a dozen different Tubing Head Suspensions and Hook-Ups. Get the full details from your nearest Baash-Ross representative—or write direct.

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Results of Cooperative Safety Efforts†

Successful safety programs mean greater earning power and good morale for employees; high efficiency and reduced insurance costs for company

HARRY HILLMAN*

SINCE 1945, the drilling industry has constantly strived to increase its efficiency and its unit of productivity, which is a foot of hole. As a result, penetration rates have been increased 56 per cent in the past six years. Industry-wide effort to increase the footage drilled and to speed up operations have necessarily resulted in tremendously increased accident probabilities. Yet, in spite of increased hazards to both men and machines, the overall accident trend in the drilling industry for the past six years has been constantly down.

In 1945, the American Association of Oilwell Drilling Contractors decided to initiate a safety program that would be simple, practical, and effective for the industry. After careful consideration, it was decided that the most effective program should embody the following.

1. Inclusion of everyone in the contracting firm, from top management to the greenest crew man.
2. Usable by the smallest and the largest contractors alike.
3. Effectively operable with or without the services of a safety engineer.
4. Function in such a way that, when coordinated by the Association, it could be passed on to the industry and serve as a stimulant to all operators.
5. Coordinate and take advantage of the activities of insurance company engineers, state inspectors and all other agencies doing safety work in the industry.
6. Should be relatively inexpensive but would pay tremendous dividends insofar as decreased insurance costs.

With the foregoing objectives, in February of 1945, the first safety program sponsored by AAODC was begun. Fifteen to 30 min weekly meetings were started on various rigs under the supervision of the driller, the toolpusher, or, in a few instances, the drilling contractor himself. The reaction from the crews to the first meetings were very favorable, and, almost without exception, each crew man expressed his appreciation to the company for this oportunity to improve safety conditions under which he was working. To the worker, it presented tangible proof of management's interest in his welfare.

From this small start, the program has expanded almost industry-wide and now incorporates many features not contemplated in the original program. This has come about through the demands of the drilling contractors, who enthusiastically support the safety program, and with the help of such organizations as the National Safety Council, the U. S. Bureau of Mines, state industrial safety organizations, safety departments of the major oil companies and safety engineers employed in the drilling industry. AAODC now makes available the following services:

1. *Materials* suitable for use in safety meetings on the rig.

2. *Safety Manual* covering all phases of safe practices in the drilling industry.

3. *Color Coding for Rigs.* This program was developed for drilling rigs with the cooperation of numerous paint manufacturers and supply companies. An excellent 16 mm movie concerning this phase of safety is available through the U. S. Bureau of Mines, which laid the ground work for the color coding.

4. *Safety Hints for Drillers.* A monthly association publication available to members and non-members which contains excellent reference material for rig safety meetings.

5. *Safety Posters.* Poster services available once each month. All posters pertain to drilling industry only.

6. *Payroll Inserts.* These carry a safety message and are designed to pass out with pay checks.

7. *Safety Inspection Check Lists.* These lists cover rigs, trucks, marine equipment and boats.

8. *Safety and the Driller.* Published once each month as a letter directly to the driller.

9. *Making the Future Brighter for the Boys on the Rig.* A booklet outlining the safety programs of 12 contractors now in the field.

10. *Annual Safety Clinic of AAODC.* The seventh annual meeting was held May 19 and 20, 1952, at the Adolphus Hotel in Dallas, Texas. These are held once each year where problems concerning the contractor are discussed.

11. *Area Safety Clinics.* This is a new program instituted the first of this year, and half-day meetings are being held, or are in the planning stage, in the areas in which drilling is concentrated. These meetings are participated in by top management, all supervisory personnel, drillers and crew men, and information available indicates enthusiastic acceptance of this latest addition to the safety program.

12. *Safety Committee* work through sub-committees, which are now, for instance, preparing reports on the following subjects:

1. Minimization of slipping hazards.
2. Rig heating.
3. Reduction of rig noises.
4. Barge and off-shore operations.
5. Visual aids for safety training.
6. Safety features of new equipment.
7. Revision of Safety Inspection Sheet.
8. Study of uniform First Aid Kits.

13. *Moving Pictures.* AAODC has cosponsored a recent sound film titled "Handling and Running Casing" and is now at work, in cooperation with the University of Texas, on a new film titled "Handling Drill Pipe, Collars, and Tool Joints." Other safety moving pictures are available through the Association.

Specialized bulletins, resulting from Safety Committee studies, have been published covering rig lighting, raising and lowering derricks, proper fire fighting equipment for rigs, drill stem testing and handling of caustics. In addition to all of the foregoing, and closely allied with the Association's safety program, is the educational program sponsored by the Association, which consists of mud schools, supervisor's training course (employer unit plan), first aid courses, engine schools, and management institutes. The Educational Committee of the Association has always worked very closely with the Safety Committee because it is axiomatic that, when a man is taught to do a job in the best manner, he will be doing it in the safest manner. Conversely, the safe worker is patently the most efficient and proficient. When this program was begun in 1945, only two drilling firms had safety engineers. Now there are about 50 safety engineers working in drilling contracting firms, doing educational and personnel work along with the safety work.

†Presented before Joint Annual Meeting, AAPG, SEG, and SEPM, March 24-27, 1952, Los Angeles.

*California Production Service, Inc., Long Beach, California.

The fact that our Association has this very fine and progressive safety program does not mean that all contractors are using it. The attitude among many of the contractors has been that safety work is all right for the major companies, but the drilling contractors are too small, locations are inaccessible, crews are continually changing, the men will not attend safety meetings, and the work is inherently dangerous. These certainly are problems, but they should not be used as excuses for neglecting safety work. Another excuse used for neglecting safety work has been the rather wide-spread attitude throughout all industry, that it should not be necessary to teach men to do things that they should be perfectly willing to do for their own welfare. Given the best equipment, maintained in excellent condition, a man's safety rests pretty much in his own hands. It is rather a travesty, but men must be taught to work safely.

It is through the bitter experience derived from many years of not teaching men to protect themselves, and the example of thousands of industrial casualties with their attendant financial loss and human suffering, that all industry has come to realize the absolute necessity for teaching men to work safely. Perhaps the most important failing on the part of some of the contractors may be expressed as a lack of constant interest. Reports from safety engineers, insurance companies, and State Accident Commissions show that the universal complaint is "that management is often as hard to sell as is the workman." The employee interest in safety will be only as active and last as long as the drilling contractor's interest. The slightest indication that the men at the top regard safety work as a fad or a fetish will almost immediately be reflected in a lack of interest on the part of the workman coupled with a consequent increase in accidents. The contractor with a consistently poor safety record will invariably have a low morale among his men, and, as we all know, the oilfield grapevine is a very efficient system for news dissemination. Once the contractor has established a reputation as an unsafe operator, the reputation spreads and is almost impossible to live down. A good safety program is as essential to a drilling contractor as a rig and a string of drill pipe. The U. S. Bureau of Mines recently pointed out that in all industry, companies with no safety programs have 24 times as many accidents as companies who do have safety programs. There are two other essentials to a good safety program. The first is that we must keep records if we want to see results. No one likes to do anything without seeing results. We all like to accomplish great things, but we also must see that accomplishment; to see these results we must keep records—records that will show us that we have had accidents and what they cost us; they will also, after a while, give us a picture of what our safety program is doing. The other essential to a good safety program is proper and immediate accident investigation. We are all too prone, when making an investigation of an accident, to merely "fill in the spaces" of the accident report form. A thorough and conclusive investigation, one that definitely pinpoints the reason for the accident, produces two very beneficial results; first, it points up the cause and indicates the remedial action necessary; second, it is a very excellent safety meeting in itself.

The rewards of a successful safety program are not all to the employee in the form of uninterrupted earning power and freedom from painful injury. From the contractor's standpoint, the results are two-fold—one intangible and one tangible. As to the intangible benefits we can point to improved production, pride of workmanship, the feeling of belonging, personal pride in company achievement, a feeling of wanting to help resulting in more economic use of material and supplies—in a word, good morale. It is hard to evaluate the importance of the morale factor, but anyone familiar with the labor problems during these last few years, when morale has been difficult to maintain because of labor turn over, labor shortage, etc., can fully appreciate its importance. Of course, the endpoint of these intangible benefits is certainly a very tangible benefit—namely, reduced operating costs.

The tangible benefit received from a successful safety program is a reduction in workmen's compensation insurance costs, along with other insurance costs. Experience teaches us that, however well conceived or executed, no safety program can be 100 per cent successful, for, regardless of how much improvement may be made in the field of safety, accidents do, and will continue to, occur. Furthermore, the element of contingent exposure is constant and unavoidable, even in the absence of actual loss. In order to provide compensation benefits and liability protection to persons and property where accidents occur, insurance is made necessary. Aside from statutory requirements, the extent of the limits and coverage to be maintained is a matter of company policy. Thus, a sound safety program and well-planned insurance coverage, while clearly distinguishable, should not be considered as separate or independent ventures as they are inseparably related. When properly integrated, they provide the only practicable solution to the risks—both insurable and uninsurable—inherent in drilling operations.

Safety in the oil well drilling industry costs big money, but the amount spent upon the constructive approach toward preventing acccidents, particularly if we take advantage of the forms, awards, services, etc., published by our Association as well as the outline of operation of safety program, is negligible when compared to the huge sums spent annually to protect itself against financial loss due to accidents. Over ten million dollars each year are paid to insurance companies for compensation insurance coverage alone, and these costs are based on the accident experience of all companies engaged in drilling and well servicing operations. As the overall experience of the industry improves, the manual rate is reduced for all operators and contractors alike. As the contractor with a successful safety program improves his record at a rate faster than the average for the industry, he benefits proportionately through a credit rating of his insurance and through what can be very substantial dividends. A 10-rig contractor in California will have a $50,000 per year premium to pay on his workmen compensation insurance, but a very good safety record for the year will yield him a dividend of over 50 per cent of that premium in addition to all of the intangible benefits of accident-free operations.

In California, the compensation insurance rate for drilling was over $9 per $100 of payroll in the early 1930's and gradually, assisted by the leadership and guidance of the California Division of Industrial Safety—they often guided us with a big club—came down to an all-time low of $5.02 in the 1945-47 period. Due in part to a not-so-good experience in the war years—in those days rates were arrived at over a period of 6 years—but mainly to increased costs of insurance benefits, rates have gradually risen since 1947. If, however, we apply the Bureau of Labor Statistics Cost of Living Index, which is a pretty fair index to all prices and costs, to the 1940 rates, one would find that the rate in 1952 in California, had we not had a constantly-improving safety record since 1940, would now be over $10. Increased weekly benefits, however, doubled medical costs and increased disability awards have almost exactly offset the improved safety record of this 10-year period. Rig insurance rates more clearly reflect the improvement of California operations as they moved from $2.50 in 1940 to $1.25 in 1952.

Another example can be shown by what happened in Texas. The compensation rate declined 35.5 per cent between May 1, 1938 and February 1, 1950. Based on a payroll that annually runs about $70,000,000, this amounts to an annual decrease in costs in Texas alone of over $2,500,000. In Illinois, the rates have reduced annually since 1940. At that time, the rate was $10.97—today it is $4.41. But let us not lose sight of the fact that these reductions were achieved solely through reduction of frequency and severity of accidents, and in spite of increased costs of benefits amounting to from 50 to 100 per cent.

Let's take a look at what reduced insurance costs mean to a Tri-State contractor with four rigs whose annual payroll runs about $300,000. In 1941, his Workmens' Compensation cost was $30,990 and his rig insurance was $11,900 for a total insurance cost of $42,890. In 1951, compensation cost him $12,720 and the rig insurance cost was $4250, for a total cost of $16,970—an annual saving of $25,920 or 60 per cent. Again let me say that these savings have been possible only because of improved safety records. Along with reduction of com-

pensation and rig insurance costs has been a reduction in the other insurance costs, with the exception of auto and truck insurance premiums. Automobile and truck safety improvement, the only manner in which these insurance rates can be reduced, is a national problem of great consequence, one which is getting attention from many sources.

For years our insurance companies have told us that our actual accident cost is four times the amount that our workmen are paid by the compensation insurance carrier, to say nothing of the equipment loss if the accident involves damage to the rig. Recently a member of AAODC kept a record of what an accident cost him. He is Howard Walton of Fairfield, Illinois, and this is his story.

On January 31 of this year, the crew was making a connection, when the tongs slipped hitting a crewman in the chest and knocking him through a brace in the portable derrick, hitting his head as he went through, rendering him unconscious. The crew proceeded to try to revive him. They were unable to do so, and a discussion resulted as to whether he should be moved or not. It was decided to take him to the hospital at Washington, Indiana — a distance of about 15 miles. Due to the mud at the location, it was necessary to carry him to the car on a stretcher. Some time after they had left the rig, the pusher arrived and was informed of the accident. After waiting for some time to see if the boys would be back, he also left for the hospital. The injured crewman recovered consciousness but was held by the doctor for a couple of hours for observation for possible unseen injuries. Word of the accident reached Walton, and he made a trip to the location, a distance of 80 miles. By the time he arrived about seven hours later the rig was running again with the injured man at his usual place, and showing no ill effects. The direct cost to the insurance company for this accident was $7.50 and the indirect cost to Walton was $120.00. In this case Walton paid $16 for every dollar the insurance company paid. You gentlemen know, if you will seriously think about it, that this is not an unusual example but rather it is extremely typical.

A mistake that is made all-too-often by management is in thinking that they can hire a safety engineer, or buy a safety program, and *PRESTO*—no more accidents. This is as fallacious as the contractor who says that accidents are bound to happen and there's nothing he can do about it. Prevention of accidents is a direct operating function, and the administration of the safety program must be done by operating personnel. We have seen this mistake made in our own Association. A contractor develops a poor safety record, his insurance is cancelled, or cancellation is threatened, so he salves the insurance carrier and his own conscience by hiring a safety engineer. But, no change has taken place in his concept of his management responsibility and so his accident record gets no better—maybe it gets worse. Another contractor with a poor record approaches the problem analytically and constructively, comprehends the manifold benefits he can derive from a reduction of accidents, accepts his responsibility, as an employer, to provide a safe working place and safe working conditions, puts on his hard hat and goes to work on his tool pushers and, *through and with them*, on his drillers. You can bet your last 50-cent dollar that that man is going to get results—with or without the services of a safety engineer or a formalized safety program.

The safety engineer, the safety program and the various safety services that are available are not alone the answer to prevention of accidents. They are of very great assistance and should not be underrated, but it is the operating man who is solely and unequivocally responsible for success or failure. The accident prevention problem of the contractor and any one of his drillers are identical—with one exception. This single exception is the degree of responsibility. The driller is responsible for his crew during his tour; the contractor is responsible for the safety of all of his crews all of the time. As an example, let us think of a contractor's organization as a stairway. The top step is the contractor himself, on the next step are area superintendents, the next step are

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the toolpushers, the next are the drillers, and the bottom step are the crewmen. There is a hand rail down the stairway that will help considerably in descending safely, but it won't, of itself, guarantee it. This hand rail is the safety engineer and the formalized safety program. With the aid of this hand rail, our accident prevention program starts down the stairs of the organization towards the goal at the bottom—a goal called "Accident Free Operation." If, because of apathy and a feeling that safety is sissy stuff, the contractor is not cooperative in the program, we slip on the top step, and the whole program is busted—safety is left in the lap of the God of Chance. If, on the other hand, the contractor is sold on the value of the program and sells it to his area superintendents but the tool pushers are a little wobbly and won't buy it, we have gotten half way down the stairs towards our goal, but we still slip on the wobbly step and our program gets busted to pieces. The accident prevention program takes a firm grip on the hand rail, the superintendent gets some valuable assistance from the safety engineer and the formalized safety program and, *together*, they sell the toolpushers. We're now another step towards our goal, but it's still some distance off. If the toolpusher, like the superintendent, takes a firm grip on the hand rail and accepts and uses that ever present valuable assistance of the safety engineer and the formalized safety program, he *too*, will be able to sell his drillers and they, by like means, will sell the last element in the series of operating men—the crewmen.

In this manner, and this manner only, can we reach the goal of "Accident Free Operation." Some organizations may be able to skip blithely down the stairs without touching the hand rail, but these are exceptional, if they exist at all.

In the average organization, the attempt to prevent or reduce accidents is going to slip and crash somewhere down the stairs between the boss and the boll weevil hired yesterday. And, if the efforts to reduce accidents "come a cropper" at any level of the operating organizations, the desired results are not forthcoming. A good safety program, with or without a safety engineer, is indispensible to a drilling contractor, *but you can't buy safety*. The program is of tremendous assistance to the operating personnel, but alone it is valueless. Safety is nothing but plain, hard work. The harder every man works at this job of safety, with his efforts guided and assisted by a good safety program, the better will be the results and the sooner they will be attained. And, finally, when the desired goal is reached, it's still a matter of continuing hard work to remain at that goal. *Safety is no accident.* Safety is the result of hard, intelligently planned work of every man in the organization, from top to bottom, and the results are going to be in exact ratio to the planning and the effort that goes into it.

Which, like everybody else, reminds me of a story.

A minister was invited to deliver a sermon as the guest of a church in a neighboring village. Upon his arrival at the church with his young son, he noticed a box on the vestibule door for receiving contributions. As he passed, he dropped in a half dollar, and then became busily engaged in meeting his congregation and delivering his sermon. As he was leaving at the end of the services, one of the deacons pointed to the box and informed him that this was used for collecting contributions as a reward for guest ministers. The deacon opened the box and handed the minister its contents—a lone half dollar. Whereupon, the small son looked up and said, "Dad, if you want to get more out of it, you'll have to put more into it." * * *

☆ ☆ ☆

The first state gasoline tax was levied in Oregon on February 15, 1919. It was a 1-cent tax. Motor fuel tax receipts for calendar year 1920 in Oregon totaled $443,375. Receipts in calendar year 1950 in that state were 63 times as great, or $28,027,000. With an average retail gasoline price of slightly over 2 cents a gallon in 1950, a resident of Portland, Oregon, could have bought over 100 million gallons with the Oregon receipts.—*Tax Outlook.*

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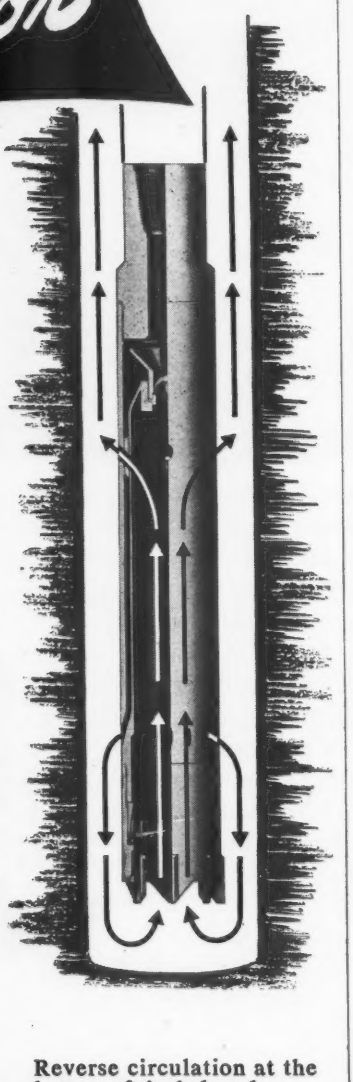

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Italian Natural Gas Industry

Seismic reflection techniques marked the turning point in a fairly recent development, but political controversy, lack of pipe lines hamper exploitation

V. S. SWAMINATHAN

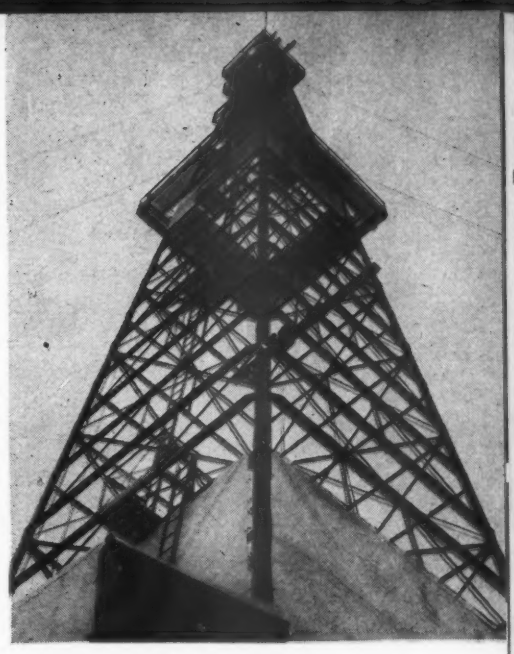
THE industrial exploitation of natural gas in Italy is a relatively recent development. In 1926 the state assumed direct responsibility for the exploration of oil and natural gas resources through the newly created Azienda Generale Italiana Petroli (AGIP). The introduction of geophysical, gravimetric, and magnetometric methods of investigation by this organization led to natural gas discoveries at Fontevivo and S. Giorgio-Podenzano, near Piacenza. But it was the seismic reflection technique, first employed in 1939, that marked a turning point, and resulted in the location of the fields of Caviaga (1941) and Ripalta near Lodi (1948), of Cortemaggiore and Piacenza (1949) and Cornegliano near Lodi (1950).

Most of the natural gas produced by AGIP (accounting for 90 per cent of the country's total output), comes from Caviaga, Ripalta, and Cortemaggiore. The Podenzano-S. Giorgio field is only of limited importance, yielding 530,000-704,000 cu ft a day. The Cornegliano field remains to be tapped. Until the end of 1951 wet gas from Cortemaggiore was treated in the same fashion as dry gas from other fields. After reducing its pressure from approximately 2000 psi to 800 psi, it was passed through a gas-oil separator and then let into the methane pipe line. In January (1952) the natural gasoline recovery plant at Cortemaggiore, claimed to be one of the largest in Europe, started processing 106,000,000 cu ft of methane daily. It is producing over 2000 bbl of condensate a day, 50 per cent of which is motor spirit, and the rest is propane and butane, which is liquefied and sold for household heating and cooking purposes. A small quantity of gas oil is also obtained.

Late in 1951 production of methane averaged 89,000,000 cu ft per day. There were some 80 wells in operation reaching depths of 5000 to 10,000 ft. According to a recent statement by the vice president of AGIP some 30 new structures have already been discovered in the Po Valley, which still has been only partially explored. Investigations underway in Marche, Puglie, and Lucania have shown encouraging results. There are 12 crews engaged in geophysical prospecting, employing the latest techniques including seismic reflection and telluric methods. Chemical and physical tests, petrological and palaeontological studies on cuttings and cores are carried out in the AGIP laboratories at Lodi. The efficiency of this facet of AGIP's activities is indicated by the high percentage of productive wells among those drilled, which is approximately 10-fold the average obtained in the United States. Drilling is done partly by private companies and in part by AGIP itself, with the aid of U. S. technicians from the Santa Fe Drilling Company. Rigs used are of a modern type including a 2000 hp Ideco rotary capable of reaching 16,000 ft.

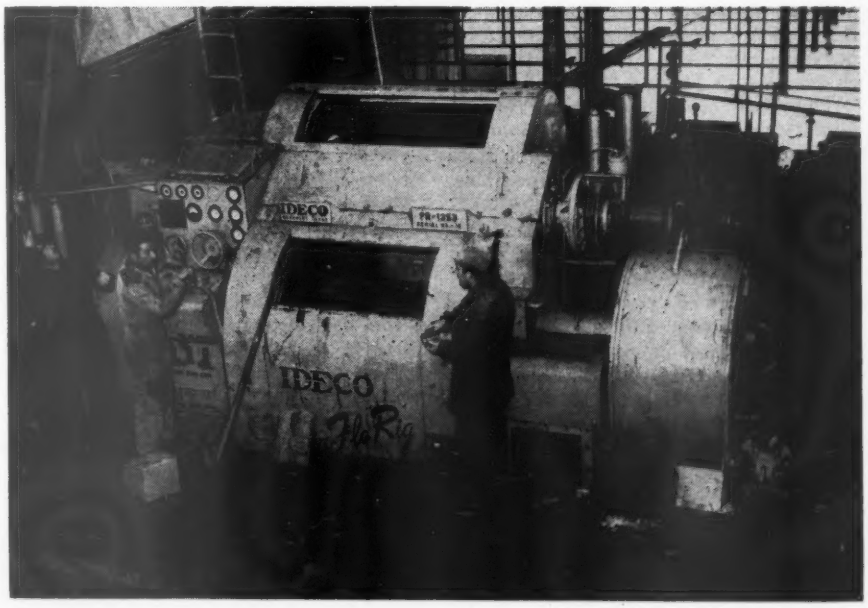
At the beginning of 1952 there were over 100 wells in operation, with a potential daily output capacity of 350,000,000 cu ft extending over a period of 15-20 years. This would represent one-third of Italy's current consumption of imported fuel averaging 28,000 metric tons of coal (equivalent to 670,000,000 cu ft of methane) and 75,000 bbl of oil (equivalent to 350,000,000 cu ft of the same gas) a day. A further increase in methane production is foreseen in the next few years.

AGIP recently announced the discovery of gas at Bordolano in the district of Milan. Drilling was begun in August with a German rig following a geological survey, and on November 26 the well began producing natural gas at 7,000,000 cu ft a day. In view of this discovery AGIP decided to drill two further wells in the same area, and the rig for one of them has already been erected. This gas strike means that when the projected gas grid is completed the estimate of natural gas available from the Po Valley can be put at 423,000,000 cu ft a day. German oil field equipment



Rotary rig with drilling capacity of 16,000 ft in use by AGIP at the Cortemaggiore field.

Modern rotary rig operating at Cortemaggiore field has drawworks and engines covered to protect them from bad weather.



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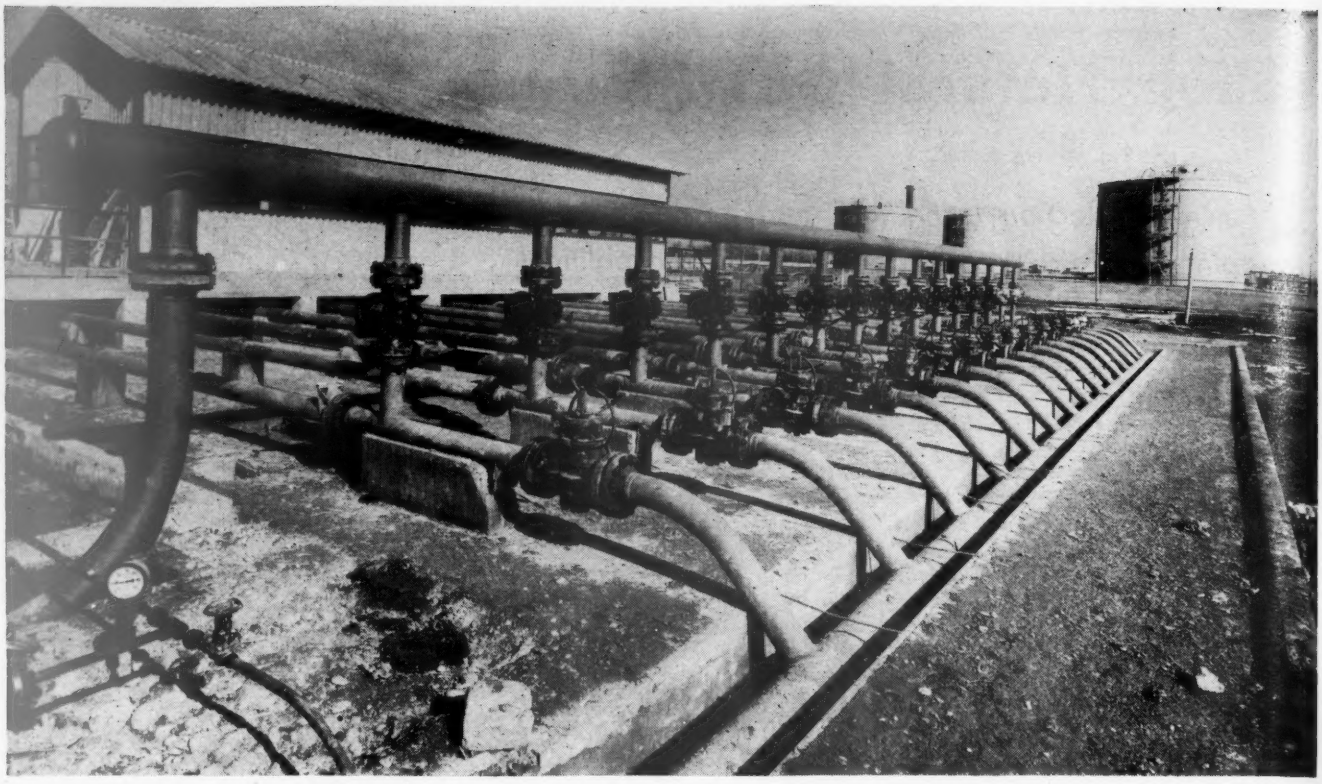


Gasoline extraction plant at Cortemaggiore field, Italy.

manufacturers have offered their assistance to AGIP, and the Italian Government has agreed to the importation of such equipment and machinery provided they can be paid for in agricultural products.

There are, however, difficulties in the way of using such capacity to the full, namely the problem of transportation. This can be solved only by the construction of a network of pipe lines reaching major industrial centers. Pipe lines now in use serve mainly Milan and the minor centers of Lombardy, and have a total length of approximately 410 miles, with a daily discharge capacity of 226,000,000 cu ft. Another 170-mile line, with a discharge capacity of 163,000,000 cu ft a day, is under construction and a 16-in. line, 110 miles long, will link the gas fields with Turin.

The AGIP controlled Societa Nazionale Metanodotti (SNaM), responsible for the distribution of methane, is planning to build 620 miles of pipe lines, with a daily discharge capacity of 302,000,000 cu ft. When this is completed methane will be available in the whole of Northern Italy from Bologna to Como, and from Venice to Turin and Genoa. Once the main lines are laid connections must be provided to bring methane into the factories. For the time being priority has been accorded to big customers who though they represent only 2 per cent of the total, absorb 50 per cent of the output. Some of the larger concerns—Pirelli Rubber Works, the Dalmine and Falk Steel and Iron, and Montecatini Chemical — have already switched over to methane in many of their factories. It is more difficult to satisfy the needs of medium and small industries, which are numerous and scattered over a wide area. This largely accounts for the gap between capacity and consumption of gas.

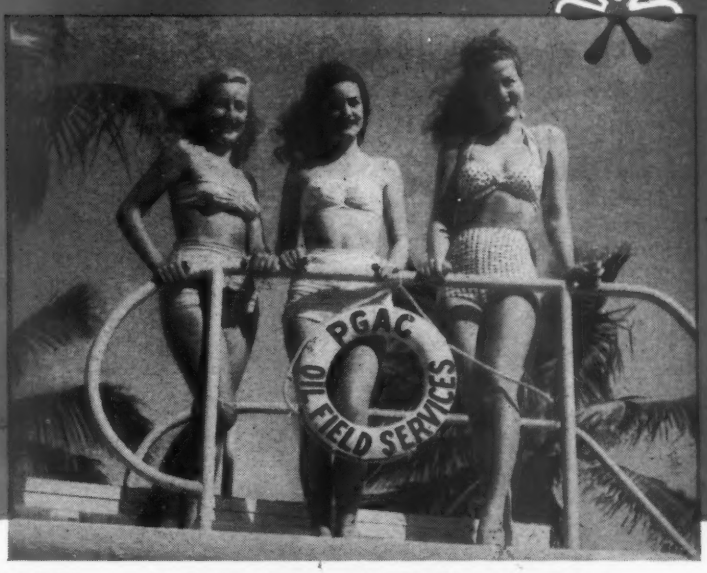
Methane provides 255 calories per cubic foot, compared with 127 of coal gas; it offers many advantages over solid and liquid fuels and being cleaner it ensures a better preservation of plants; it does not need much reservoir capacity or make demands on other forms of transportation once the factory is connected with the pipe line. Above all, its price is competitively attractive. The present policy of AGIP-SNaM is based on the market price of oil, and discounts from 25-30 per cent are normally granted according to type of user and quantity consumed.

Of particular importance is the use of methane in thermo-electric plants. Italy's hydro-electric system is already highly developed, but a further expansion is hindered by rising costs since the most favorable sites had already been utilized for generating power. Erection of more thermal stations had hitherto been handicapped by the country's dependence on imported coal, but the use of methane removes this obstacle. Experiments made have proved successful, and a big thermal station with a capacity of 600,000,000 kwh a year is being built at Tavazzano (Piacenza). The conversion of methane would also provide an answer to the difficulty of supplying small industries scattered over a wide area. Methane can, moreover, be utilized for the production of synthetic alcohol, petrol, resins, and hydrogen. The gas is not widely used as a domestic fuel as this application calls for additional lines. So far they have been laid only in small towns such as Lodi and Piacenza. At Milan 30 per cent of methane is mixed with 70 per cent of coal gas. According to Signor Campilli, Minister for Industry and Commerce, the Italian Government will encourage exploitation of natural gas both for fuel, light, and as raw material for manufacturing chemicals by the grant of credit and other facilities, provided such development reduces the importation of solid and liquid fuels and other raw materials.

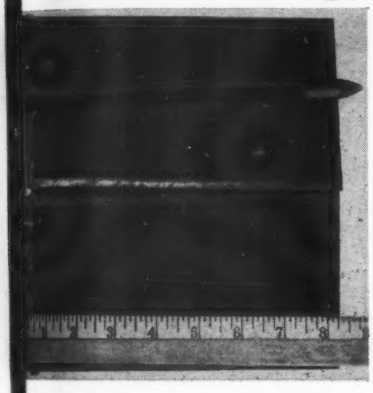
This increasing exploitation of natural gas in Italy has aroused acute controversy between supporters of State monopoly and those who advocate free competition. The Italian Parliament will shortly be asked to ratify the Italo-American Financial Agreement signed in Washington during the visit made by Premier Signor De Gasperi late in 1951. It will include matters that concern the investment of U. S. capital in Italian gas and oil industry; the agreement of the Government not to hamper American economic enterprises in Italy, and the freedom that will be conferred on the transfer to the United States of profits made by American investors in Italy. This has been criticized by the left wing opinion in the country. It is generally conceded that AGIP has done an excellent job, and since the investments required in an initial state would be heavy, only a few big private concerns could enter the field, so that there is danger of a private monopoly being formed in place of a State one. A compromise solution is offered by a bill now

Choosing a BLONDE a BRUNETTE a REDHEAD

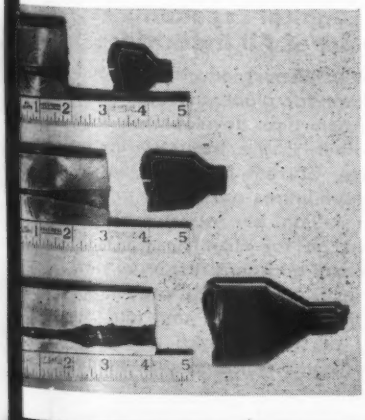
...that's one helluva risky job... and no one can help you!



—but choosing between JET SHOT and BULLET PERFORATING... here's a problem PGAC can sure help you decide...and safely!



ross-section shows two halves of target used Atlas Bullet test. Target was 4" O.D. pe, with one end plugged by a welded " plate of SAE 8640 steel (tensile strength 0,000 p.s.i.—harder than N-80 casing). re cement poured into target hardened 7 ys before shooting with standard load and uipment. Bullet penetrated entire cement get—greater depth is easily possible. ilar tests produced similar penetrations—of of repeatability.



Why do some men prefer Blondes, while others choose Brunettes or Redheads? Frankly, we don't know. And strange enough, not even Washington has risked its controls and forecasts in this field!

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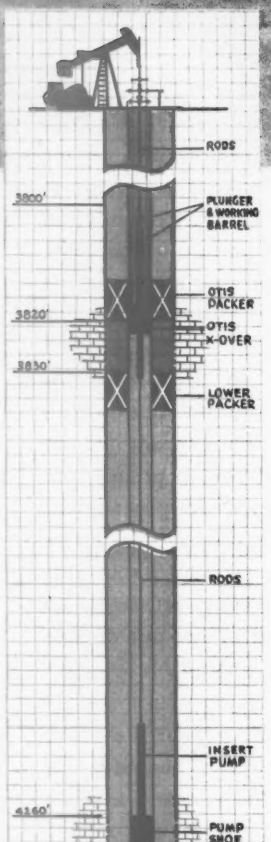

If you are operating in a field with several good horizons, you will want to investigate this Otis equipment for pumping two formations through a single well bore. The Otis Two-Zone Pump is an assembly of two sub-surface pumps which stroke simultaneously on a single rod string. There are no complex fittings or complicated sub-surface installations, nor is any extra surface equipment required, other than an additional flow line at the wellhead. The lower zone is pumped in the tubing and crossed over into the annulus by means of a special Otis Cross-Over Packer which also serves to separate the two zones; at the same time, another pump produces the upper zone through the casing and into the tubing to surface *(see diagram)*. Actually, both formations are pumped in the conventional manner and at no time do the fluids commingle. Otis Two-Zone Pumps are in successful operation in multiple-pay fields throughout the Mid-Continent area. If you have production in such a field, ask your nearest Otis office to show you how you can pump a *second* oil well profitably and economically, and with a surprisingly small outlay for extra equipment. Or if you prefer, we'll be glad to send you illustrated bulletins containing complete details on this and other Otis equipment for producing both pumping and flowing multiple-zone wells. Contact Otis Pressure Control, Inc., 6612 Denton Dr., Box 7206, Dallas, or the Otis office in **Houston, Corpus Christi, Victoria, Falfurrias, Longview, New Iberia, Houma, Shreveport, Oklahoma City, or Elk City.**

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Otis Two-Zone Pump

OTIS PRESSURE CONTROL, INC.

under discussion. This would maintain the state monopoly in the Po Valley where AGIP has already done the lion's share of the work, and allow private enterprise to participate in the exploitation of oil and natural gas in the rest of the country. But private companies—Italian and foreign — are not satisfied with this solution and the controversy continues.

The average depth of producing wells in the important Cortemaggiore field is 5415 ft and the producing formation is Upper Miocene sand. Composition of its gas, gasoline distillation, and oil distillation is given below: * * *

(A) Typical analysis of Cortemaggiore field gas.

Component	Volume Per Cent
Methane	91.0
Ethane	4.4
Propane	1.5
Butane and isobutane	0.8
C_5 plus	0.6
Nitrogen	1.7

(B) Distillation data-Cortemaggiore field gasoline condensate.

Temperature (°C.)	Volume Per Cent
50	9.5
80	25.5
110	55.0
140	75.0
170	87.0
200	91.7
Recovery, per cent	94.0
Residue, per cent	2.5
Loss, per cent	3.5
End Point, °C	206
I.b.p., °C	29

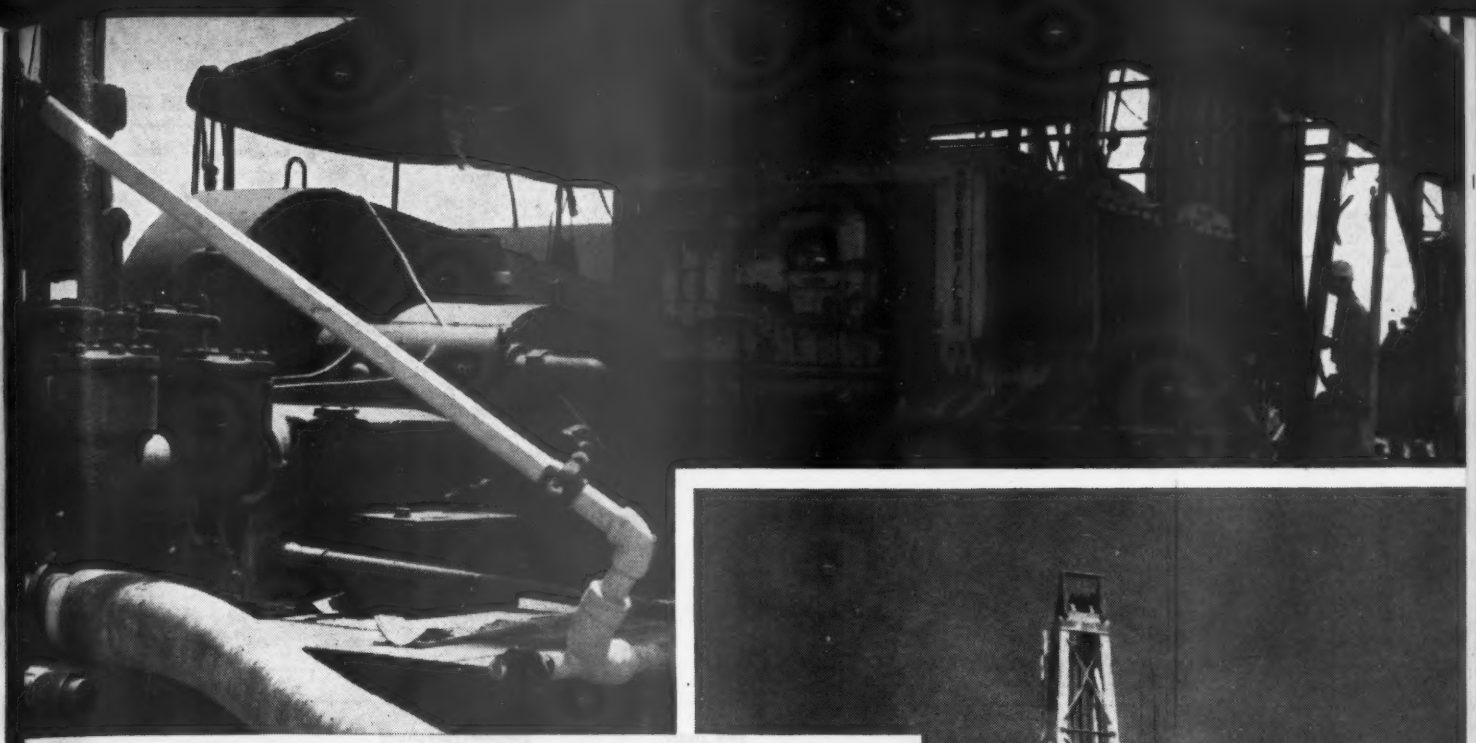
(C) Distillation of Cortemaggiore crude oil.

Temperature (°C.)	Volume Per Cent
50	2.5
100	22.0
150	50.0
200	67.5
250	78.5
300	86.5
350	91.5
I.b.p., °C	30
End Point, °C	370
Recovery per cent	95

* * *

Oil's Capital Expenditures Highest of All Industries

The petroleum industry is spending more for plant and equipment expansion and development than any other single industry in the country. Current petroleum industry expenditures are at the rate of $600 million per quarter. These millions go for maintenance, improvement and construction of new facilities for the finding, producing, transporting, refining and marketing of oil. Next largest in capital outlays is the iron and steel industry, with estimated current expenditures of $480 million per quarter. The chemical industry ranks third, followed by the automobile and machinery industries. This indicates that the job of keeping the nation supplied with oil is a big job.—API.



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Three "Caterpillar" D13000 Oilfield Engines are compounded to power the draw works and mud pump of J. D. Ferrell's operation in Thomas County, Kansas. Drill stem testing at 4,000 feet, it takes about an hour to come out of the hole and 1½ hours to go back in. The "Caterpillar" team furnishes steady power—and plenty of it!

In addition to these D13000s, Mr. Ferrell has three more on another rig. He finds that it pays to standardize on "Cat" Oilfield Engines. All equipment is interchangeable. And the engines are so rugged they deliver power day after day with a minimum of attention.

Rugged as they are, "Caterpillar" Oilfield Engines will do an even better job for you if treated right. And that doesn't mean you have to pamper 'em. Just give them a few minutes' proper maintenance a day and you'll add *extra* hours to their working life. Your "Caterpillar" Dealer is nearby to help, too. Wherever you are, you can count on him for fast, efficient service!

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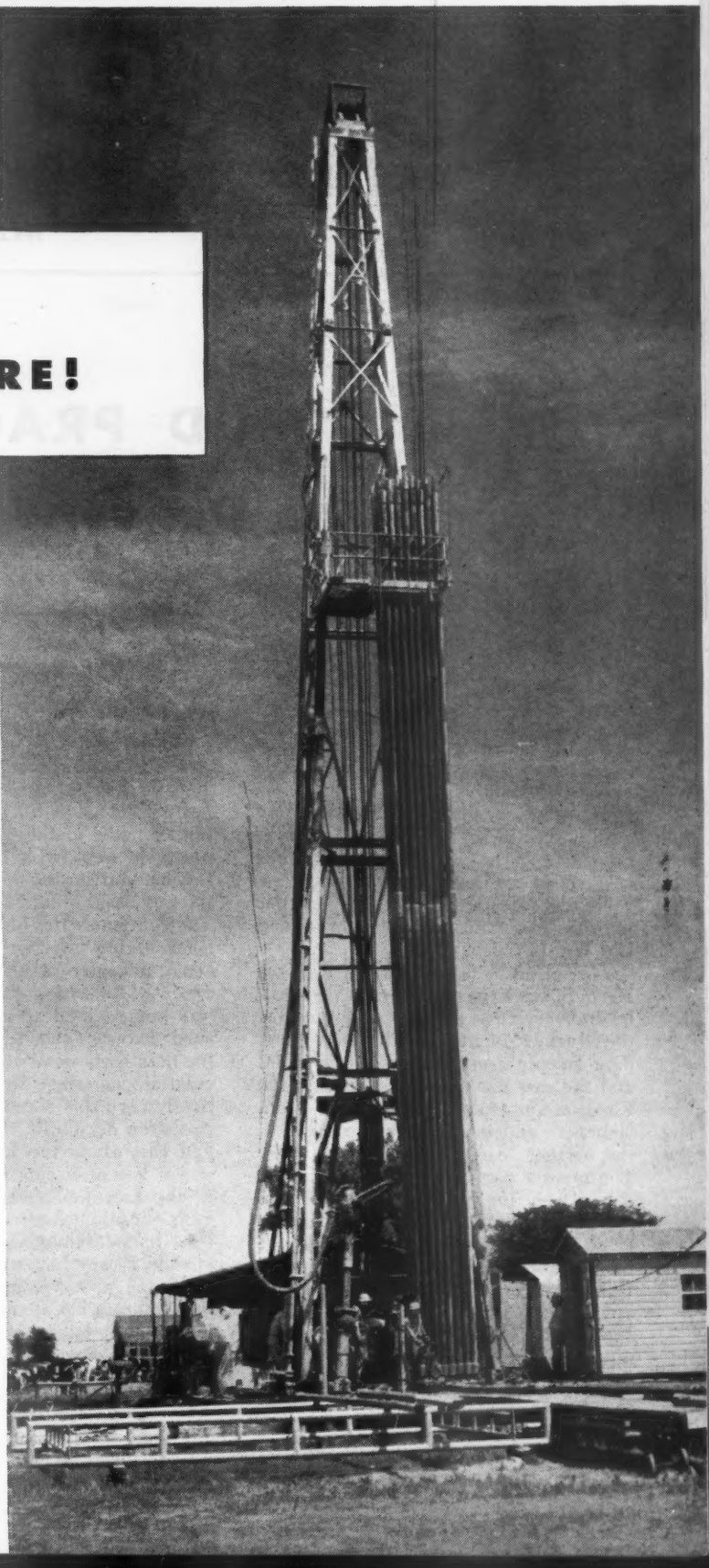

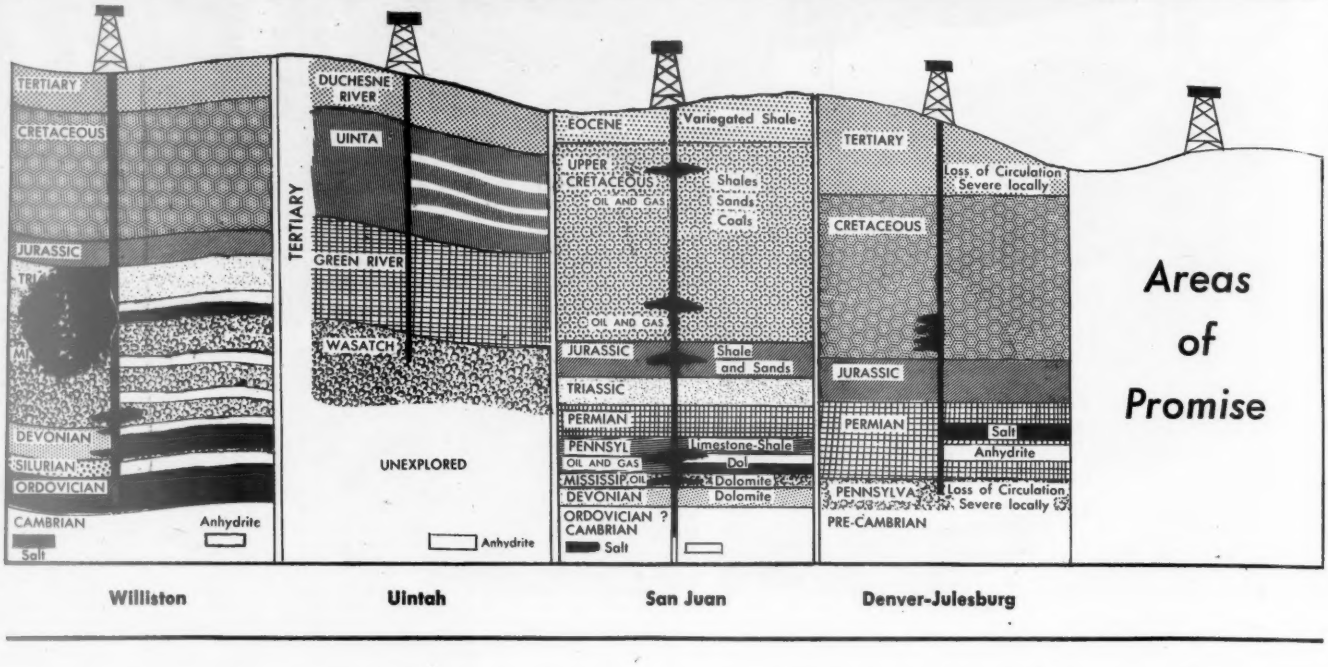

MUD PRACTICES— in the Denver-Julesburg Basin

R. L. ROBINSON

THE Denver-Julesburg Basin, sometimes referred to as either the Denver or Julesburg Basin, is a large regional syncline located in the Great Plains region east of the Rocky Mountains. The largest part of the 125,000 square miles covered by the basin is in Eastern Colorado and Western Nebraska; smaller portions extend into Eastern Wyoming and Western Kansas.

The basin is asymmetrical with its North-South axis running nearly parallel and very close to the frontal range of the Rocky Mountains. The west flank dips steeply from the mountain front and the east flank gently dips from the Chadron-Cambridge Arch in Western Nebraska and the Las Animas Arch in the extreme eastern part of Colorado. The greater part of the petroleum produced from the basin now comes from the Eastern flank. The long axis of the basin extends from the Black Hills past the Hartville uplift to the Apishapa Uplift in Southern Colorado, a distance of some 400 miles. Two areas of great depth are located near Denver, Colorado, and Cheyenne, Wyoming.

It is inevitable that in drilling an area as large as the Denver-Julesburg Basin numerous problems will be encountered. It is also natural that the oil companies and drilling contractors look to properly designed drilling mud for the solution of many of these problems. To the north, in western Nebraska, there is a section, starting at the surface, of Tertiary age averaging 1000 ft in thickness. The characteristics of this section cause considerable loss of circulation and some difficulty is occasionally experienced while setting surface casing. Partial loss of mud returns in producing sands may be expected. Pre-treatment of the mud with small amounts of lost circulation materials, however, will practically cure this condition. On the relatively few deep tests, drilled to the south and east along the Las Animas Arch, severe loss of circulation is encountered in the Lansing-Kansas City section of Pennsylvanian Age. Other mud problems include sloughing shales throughout the Pierre formation of upper Cretaceous Age, and tight hole conditions in the Niobrara chalk and Greenhorn lime formations. High formation temperatures and contaminants such as gypsum, anhydrite, and salt are encountered in the deeper section below the Cretaceous sands.

The great majority of holes drilled are to the Dakota Sands of Lower Cre-

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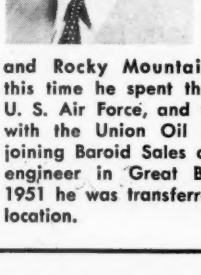
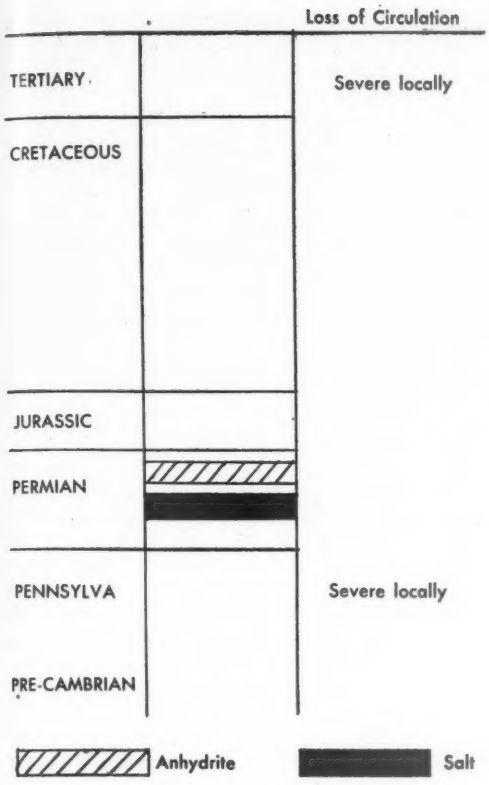
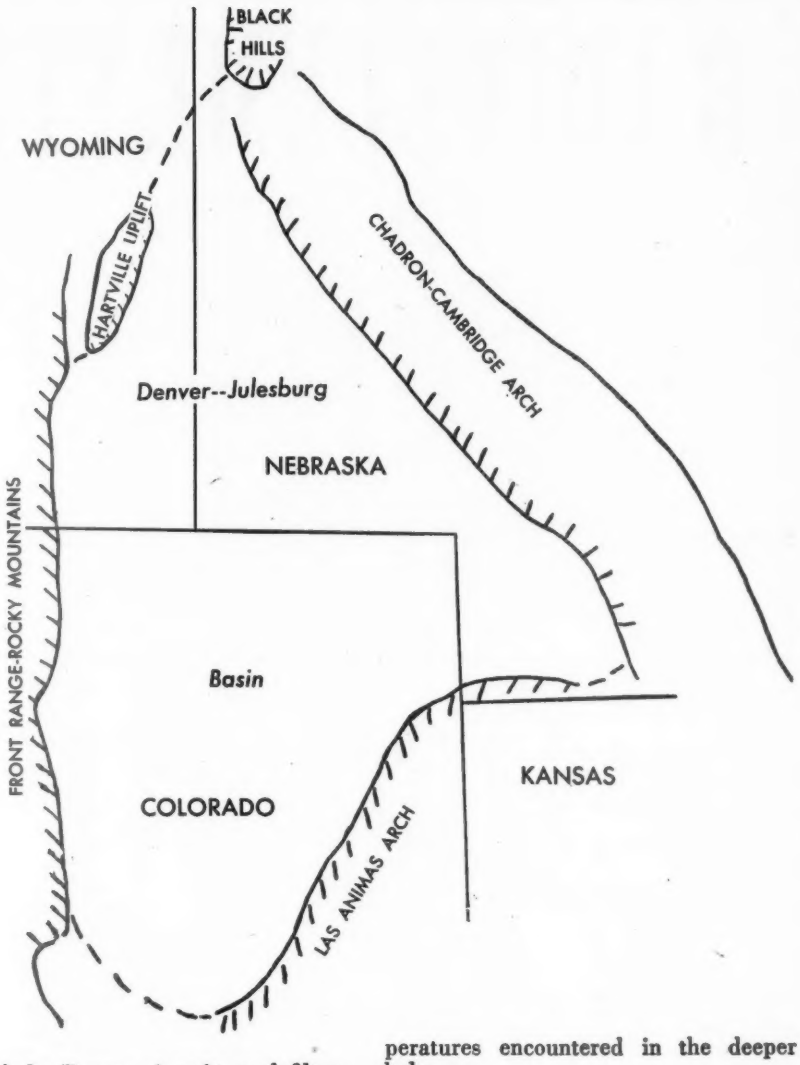


R. L. Robinson is a field service engineer for Baroid Sales Division, National Lead Company, in Sterling, Colorado. He was graduated from the University of Oklahoma in 1943 with a BS degree, and since then has worked in various oil fields throughout the Mid-Continent and Rocky Mountain areas. During this time he spent three years in the U. S. Air Force, and was an engineer with the Union Oil Company before joining Baroid Sales as a field service engineer in Great Bend, Kansas. In 1951 he was transferred to his present location.



Mud contaminant and loss of circulation log Denver-Julesburg Basin.



taceous Age. Drilling depths to the top of the first Dakota Sand, known locally as the "D" Sand, differ more than 4000 ft. This formation is found at a depth of 3300 ft in the easternmost producing field near Big Springs, Deuel County, Nebraska and at 7300 ft near Grover, Weld County, Colorado. Mud programs to the top of the Dakota sand will vary slightly depending to a large extent on the location within the basin. In general, the 3000 to 6000 ft of Pierre Shale, which lies uniformly over the area, is drilled safely and satisfactorily with native mud. Combinations of caustic soda and quebracho or caustic soda and humic type thinners are used for thinning the native mud and controlling the filtration properties. The entire Cretaceous shale section contains streaks of bentonite which makes a good native mud when treated with water, chemical thinners, and small amounts of bentonite.

The first break in the long Pierre shale section occurs at the Niobrara Chalk and Greenhorn lime formations which underlie the Pierre Shale. Observation of caliper logs, taken in several different areas, show the hole to be out of gage throughout most parts of the drilling interval except in the limestone sections. This hole enlargement is especially pronounced in the lower 200 to 600 ft of the Pierre shale and indicates that most of the tight hole condition experienced here is due to the accumulation of cuttings and cavings immediately above the near gage section of the hole. Proper viscosity and filter loss control will reduce this shale trouble in the lower part of the Pierre. When hole trouble develops, two to three trips with the bit through the Niobrara is usually required to completely clean this part of the hole. Once this is accomplished, the hole rarely gives additional trouble while testing, logging, or running pipe.

Typical mud properties on a well drilled in Logan County, Colorado, to the Dakota sand are shown in the following tabulation:

Depth, feet	3289	3966	4424	5000
Weight, lb/gal	9.4	10.1	10.0	10.0
Viscosity, sec. API	31	38	42	57
Initial gel, gram Stormer	0	0	0	0
Final gel, gram, Stormer	0	6	0	20
Filtrate, cc, API	10.0	7.2	7.0	7.4
Cake, 32nd in, API	2	2	2	2
pH, Indicator	10.5	9.2	9.2	8.8
Salt, ppm	400	400	400	400

Westward, near the axis of the basin, low pH oil emulsion muds are used to drill below the Pierre section. One of the primary reasons for using an oil emulsion mud in this area is the increased lubrication afforded to drill pipe and tools, which results in improved penetration rates and longer bit life. This type of mud exhibits good stability in the presence of the bottom hole temperatures encountered in the deeper holes.

Emulsion muds are prepared by adding either crude or diesel oil in varying amounts depending upon the desired mud properties; however an oil content of about 15 to 20 per cent by volume is most prevalent in the area. Organic type emulsifying agents, along with caustic soda, are added in sufficient quantity to completely emulsify the oil. The use of increased amounts of the organic agents will result in more stable emulsions and reduced filter losses. Typical mud properties before and after conversion to an emulsion mud on a well in Weld County, Colorado, are shown below:

	Before	After	
Depth, feet	5975	6501	6713
Weight, lb/gal	10.2	9.6	9.6
Viscosity, secs., API	43	47	68
Initial gel, gram, Stormer	0	0	0
Final gel, gram, Stormer	0	12	18
Filtrate, cc, API	8.8	3.9	3.1
Cake, 32nd in. API	3	1	1
pH, Indicator	10.0	9.0	9.5

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There have been only 15 tests drilled to the granite. All of these were drilled in the comparatively shallow part of the east flank of the basin where the granite is encountered at depths of approximately 8000 ft. Little is known as to actual depth of the granite near the axis of the basin although it has been estimated to be about 12,000 ft. In all the deep tests drilled in the Colorado portion of the basin, thick sections of anhydrite, gypsum and salt have been found in the Permian group. Apparently the massive anhydrite covers the entire basin, while the massive salt section found in the south and east thins out to stringer proportions near the southern boundary of Western Nebraska.

As previously stated, conditions are favorable for drilling the upper hole, through the Dakota group and the Morrison formation, with either a fresh water or low pH emulsion mud. Upon penetrating the Permian it becomes necessary to convert to either a salt water or gyp base mud because of the contamination effect of massive anhydrite and salt. In the areas where massive salt is known to exist, it is advisable to drill the salt section with a saturated salt water mud. Such muds minimize the formation of large solution caverns and thus decrease the likelihood of twist-offs, crooked drill pipe, and bad fishing jobs.

Saturated salt or gyp-base muds are prepared by adding salt or gypsum in sufficient amounts to completely saturate the base mud before drilling into the contaminating zone. In both mud types modified starch is added to control the filter loss at desired values. A preservative is used to prevent fermentation of the modified starch. Viscosity is controlled in both mud types by the addition of a special salt water clay. It is possible, however, to use bentonite or a combination of the two in the gyp-base mud.

While drilling with either a saturated salt or gyp-base mud, the other of these contaminants may be absorbed in saturating amounts without affecting the mud properties. Hole washouts, however, will occur through the salt section if it is drilled with a gyp-base mud that has not been presaturated with salt.

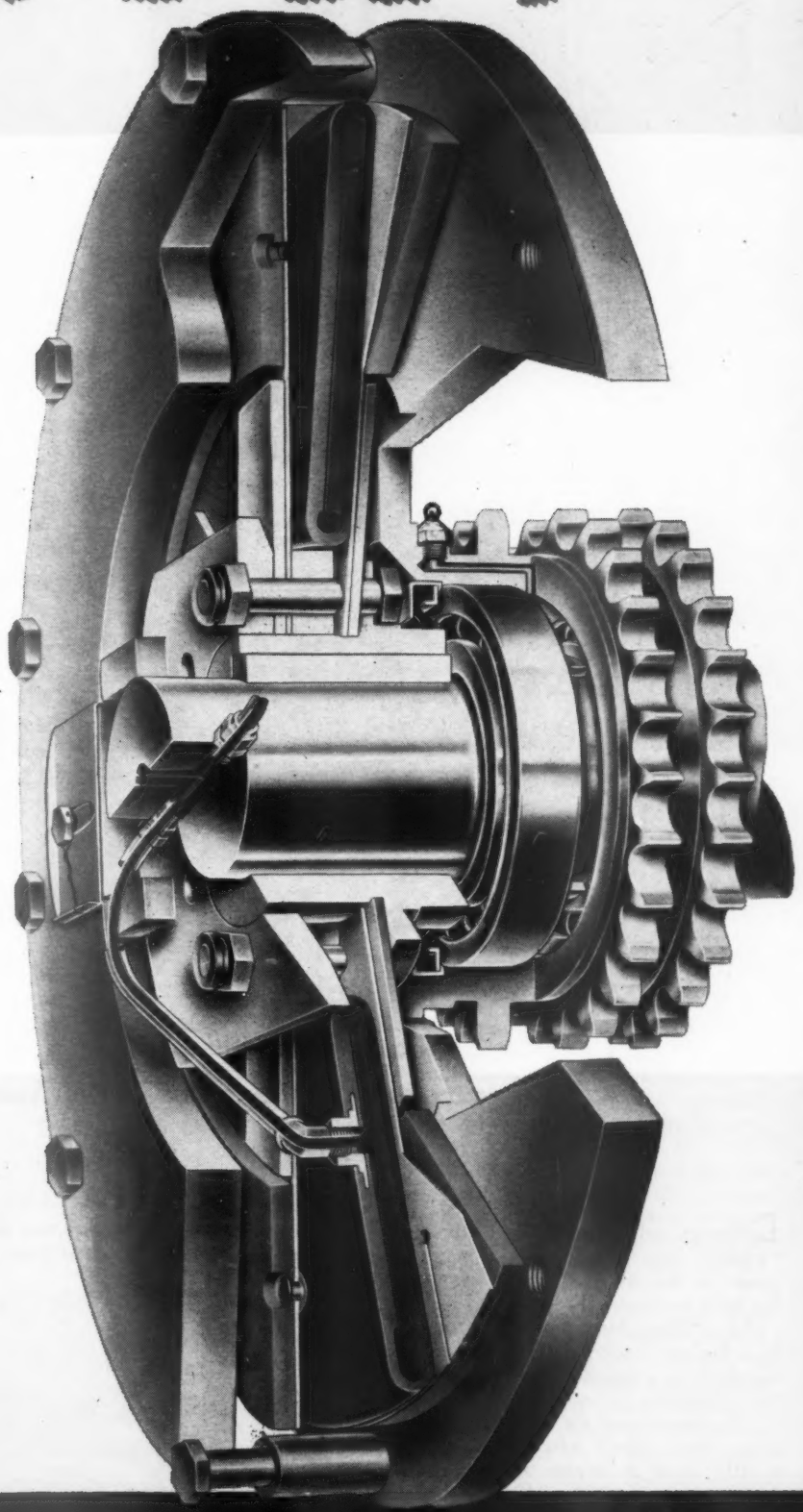
Typical properties of a salt and gyp-base mud are shown as follows:

	Salt mud	Gyp mud
Weight, lb/gal	10.6	9.4
Viscosity, sec., API	50	50
Initial gel, gram, Stormer	10	36
Final gel, gram, Stormer	25	36
Filtrate, cc., API	6.0	6.0
pH, Indicator	6.5	7.0

Conventional chemically treated fresh water bentonite muds are successfully used to drill many wells in the shallower part of the basin. As development continues, however, to deeper horizons new mud types are introduced to overcome many of the problems associated with deeper drilling. * * *

trouble in high speed friction clutches is

TEETH!



Our research on clutches has proved that when a clutch is engaged to pick up a load, the friction plates will not wear appreciably if:

(1) Materials of quality are used;

(2) Capacity of clutch is sufficient to avoid extended periods of slip.

Incomplete engagement or incomplete release of clutch plates are usually the real reasons for trouble with friction clutches. Both conditions are traceable to foreign material lodged in the gear teeth of gear-type clutches, or to improper adjustment when clutches are designed to be adjusted manually.

The Cardwell "Flex-Disc" air friction clutch has NO GEAR TEETH; requires no adjustment; cannot slip under load and cannot drag when disengaged.

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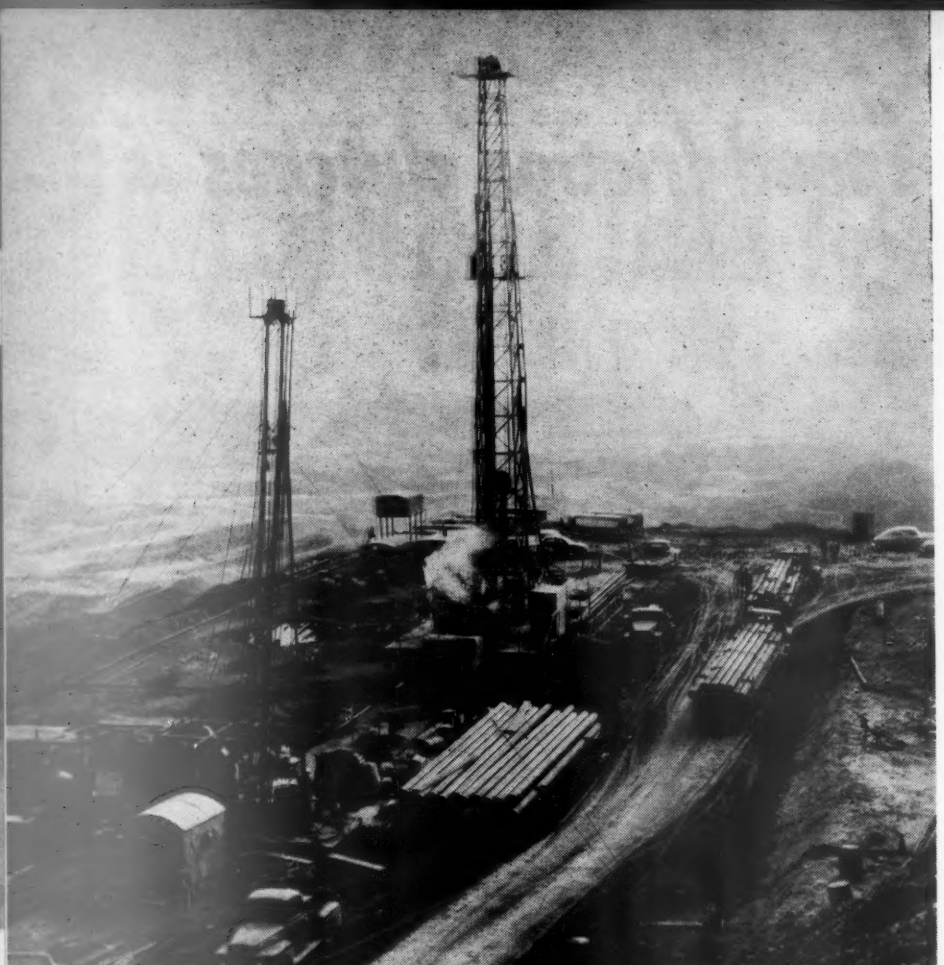


Last year, Shell purchased 940 acres of producing properties on South Mountain from oilman, R. E. Fairfield. On these mountain islands, 2000 ft up, Shell is completing surface drilling with air. Air drilling instead of the cable tool method (rig in foreground) has resulted in as much as a 50 per cent saving.

Compressed Air Drilling Cuts Costs

To combat lost circulation, Shell used compressed air in its accelerated operations in the South Mountain field

DRILLING with compressed air from "islands" carved out of 2000-ft mountain peaks is the oilman's latest weapon in his fight to reach oil reserves.

Air drilling, long popular in mining, is being used successfully at Shell Oil Company's rugged South Mountain field, Ventura County, California.

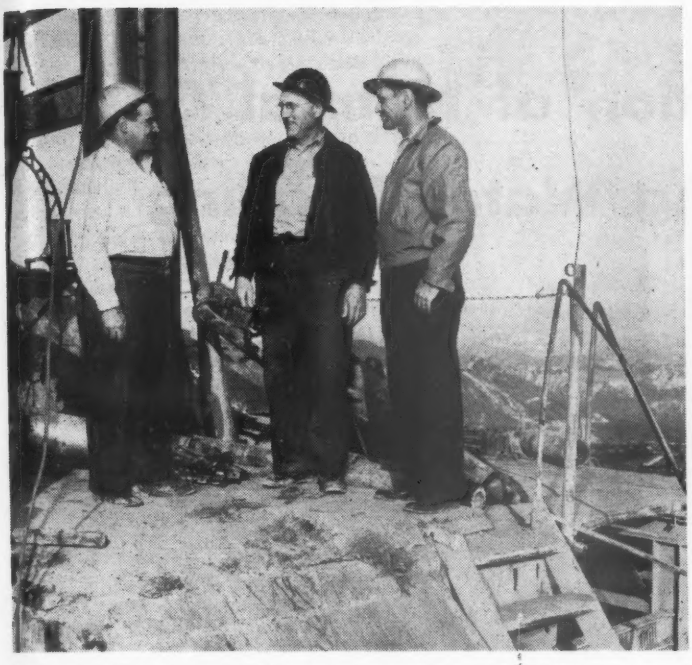
The compressed air was brought into play when Shell ran into difficulty shortly after it began an accelerated drilling program at the 940-acre oil field purchased from F. E. Fairfield last year. The terrain necessitated drilling as many as six different wells at various angles and directions in order to reach oil-producing zones beneath the earth as much as one-half mile or more apart.

Mud was lost while drilling through the first 500 to 1000 ft of subsurface, commonly called "surface drilling." The circulating mud would flow into cracks encountered by the drill bit as it penetrated highly porous and volcanic formations common in the South Mountain properties. In one well, cracks such as these had to be cemented off six different times during the first 600 ft of drilling to prevent excessive loss of mud.

Following months of experimentation, Shell's Coastal division manager, B. P. Eastin, now reports that during the surface drilling at South Mountain, compressed air has been used successfully in carrying drill bit cuttings to the surface.

Before Shell put compressed air to use in the drilling operations at South Mountain, the company carried on considerable research into the pneumatic process at its exploration and production research center in Houston, Texas. Later the method was tested by seismic crews

Five of the nine compressors that supply a constant volume of air for surface drilling as one of Shell's mountaintop island locations.



Shell's drilling foreman, G. J. Wimer (center) and district production foreman, A. H. Curry (extreme right) talk over air drilling operations with C. C. Dupuy, contract drilling foreman, on one of the drilling rigs located on Shell's South Mountain properties.

At Shell's South Mountain properties, cuttings from the drill bit, usually brought to the surface with circulating mud, are forced out of the hole by air pressure. Because of the loss of mud circulation during surface drilling, air is being used during the first 500 to 1000 ft of drilling operations.

in the field while drilling shot-holes 60 to 100 ft deep.

Prior to the introduction of the new method of drilling at South Mountain, the old cable tool method was tried in an attempt to eliminate lost mud circulation. The cable tool, or percussion, method of drilling requires no circulation of drilling mud and consequently is not affected by loss of circulation. It is extremely slow, however, and maintaining a straight hole is difficult.

Also, when surface drilling is completed with the cable tool method, the cable tool derrick and equipment must be removed and replaced with rotary equipment before proceeding to drill the hole deeper.

"Since first starting this new process in South Mountain," Eastin said, "we have completed the surface drilling by air in more than 10 wells from 3 different island locations. Air drilling has resulted in as much as a 50 per cent saving of surface drilling costs over the cable tool method through reduced drilling time."

A battery of nine compressors supplying 4180 cu ft of air per minute are used to create a constant volume of compressed air. The air is forced into the drill pipe down to the bottom of the hole under approximately 100 lb of pressure. As it escapes, it expands, cooling the bit and bringing the cuttings to the surface where they are expelled through the flow pipe under the floor of the rotary drilling table.

One of the major problems in the use of air drilling at South Mountain has been preventing the fine dust, or cuttings, as they are brought to the surface, from reaching the drilling crew on the floor of the rig.

To overcome this, a special piece of equipment, known as a Kelly pack-off (or air pack-off) has been devised to prevent the cuttings from escaping as they reach the surface and to force them through the flow pipe and out to one side of the derrick away from the crew.

The same derrick and drilling equipment used for surface air drilling can be used to continue deeper drilling operations by merely substituting mud pumps for the air compressors. * * *

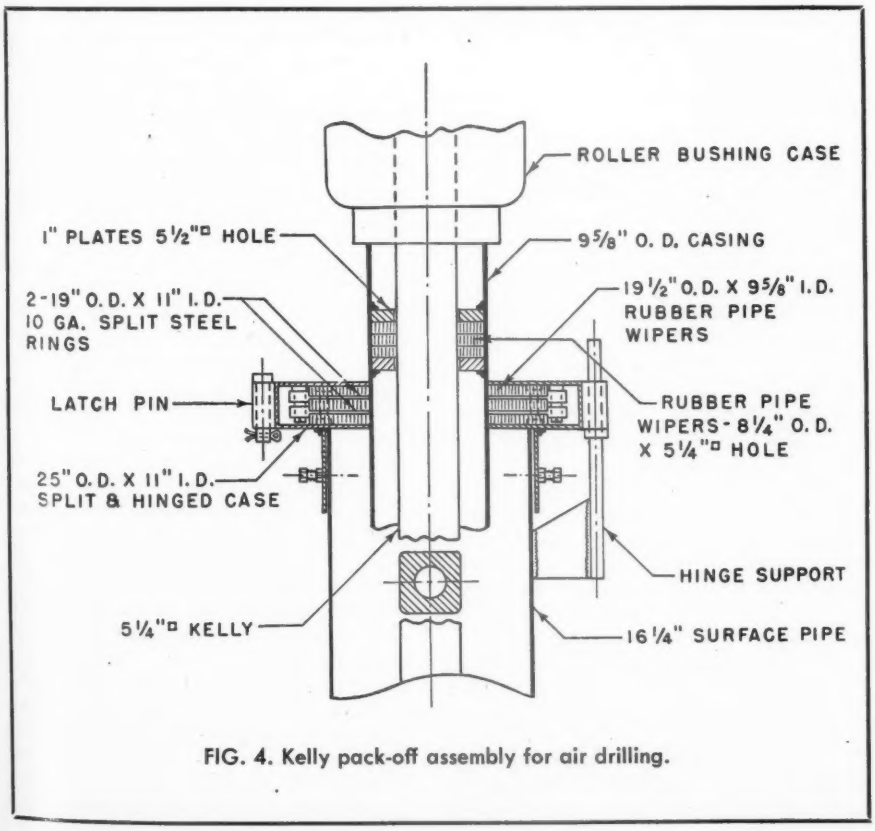

ROLLER BUSHING CASE
1" PLATES 5½"□ HOLE
9⅝" O. D. CASING
2-19" O.D. X 11" I.D. 10 GA. SPLIT STEEL RINGS
19½" O.D. X 9⅝" I.D. RUBBER PIPE WIPERS
LATCH PIN
RUBBER PIPE WIPERS - 8¼" O.D. X 5¼"□ HOLE
25" O.D. X 11" I.D. SPLIT & HINGED CASE
HINGE SUPPORT
5¼"□ KELLY
16¼" SURFACE PIPE

FIG. 4. Kelly pack-off assembly for air drilling.

A Survey of Injection of Natural Gas Before and During Water Flooding†

JOSEPH N. BRESTON*

It has been noted from a number of laboratory investigations that the presence of free gas saturation materially affects the recovery of oil from sandstone systems that have been subjected to water flooding[1,2,3]. In each case it was observed that the free gas was responsible for lower residual oil saturations than could be obtained in the absence of gas. Other investigations were deliberately aimed at the creation of a free gas phase just prior to or during a water flood in order to increase recovery. In 1932 Russel[4] experimented with some oil recovery processes using combinations of gas and water, and noted that the mixtures of water and gas bubbles produced more oil than flooding with water alone. Similarly Pfister[5] discovered that spent water drives on long cores may be made to yield additional oil by intermittent air and water injections. Holmgren[6] and Breston[7] both showed that greater recovery and lower residual oil saturations could be obtained from long cores by injecting gas along with a water flood. Most recently some experiments by Saxon et al[8] indicated that considerably increased oil recovery can be obtained by injecting a limited amount of gas ahead of a water flood operation. In some follow-up experiments Macfarlane and Saxon[9] showed that the solubility of the gas will affect the amount of oil recovered by gas injection ahead of water flooding. They observed that the less soluble the gas the greater was the recovery when gas was injected ahead of water flooding.

Before most of these experiments were performed there were an unrecorded number of instances in which water flood operators had injected gas into wells that were in or on the fringe of active flood areas. At least as far back as 20 yr ago some producers in the Bradford field injected surplus gas back into the oil reservoir. This was done mostly as a gas conservation method to insure an adequate fuel supply over the full economic life of the flood. Others did it ostensibly to thin out the crude cut paraffin, or retard a flood in a delayed drilling program. Just prior to and during World War II, acute shortages of purchased gas became a problem during the cold winter months when industrial gas was often shut off in order to maintain the supply to domestic users. Thereupon, the general practice of storing gas by injection into oil reservoirs was accelerated. Soon, purchased gas as well as lease gas was injected into properties just prior to turning in the flood water. Within the last five years this has tended to become a standard practice[10] with some companies and in a number of instances gas was injected after the floods were in progress for a number of years.

A. E. Booth and L. G. Lent of Bradford were among the earliest operators to note that gas injection into water flood reservoirs had what they considered to be a beneficial effect on oil recovery. Booth[11] describes one operation in which available lease gas was injected into a well in the center of a 14-acre area after the producing wells were well past their peak production. He observed that "within the course of a year the available lease gas increased to four or five times its original volume and the pressure at the intake well increased from 95 to 300 psig." He reports that the gas injection "definitely checked the production decline of the piece and has resulted in a per acre recovery of about 5000 bbl to date (November 1937), which is considerably higher than that obtained on an adjoining property."

A few other operators made similar observations of the apparent effects of gas injection on water flood recovery, but failed to keep accurate data, and as a result were unable to make factual comparisons with straight water flooding. At the time of these early observations, the beneficial effects of gas injection were variously attributed to increase in oil volume, decrease in viscosity and surface tension, solution of paraffin, raising the temperature by release of latent heat vaporization of the gas as it dissolves, and the storing of potential energy in the reservoir. All of these effects are real and, no doubt, contributed to the beneficial effects observed. Until recently, however, no one used the free gas theory as an explanation for the results obtained. There is still a lack of factual data by which it may be ascertained just how much each of these effects is contributing to the overall results.

Scope of Field Activity

To date gas has been injected into over 1500 wells on at least 75 leases affecting approximately 5100 acres in the Bradford-Allegany fields. Of the total acreage, 4500 acres are in the Bradford field and 600 acres in the Allegany field. Of the total number of leases 65 were subjected to gas injection before water flooding and 10 were under flood from 4 to 12 years. The sands that were subjected to gas injection are the Bradford Third in the Bradford fields, and the Penny, Richburg, Waugh and Porter, and Scio in the Allegany field. The total amount of gas injected into these reservoirs to date is approximately 775,000,000 cu ft.

Some idea of the activity may be obtained from Fig. 1, which graphs the acreage into which gas was injected over the last 17 years. It will be noted that the most intense activity occurred over the past five years. Had drilling and development been up to normal there is no doubt the average would have been higher over the past two years.

Characteristics of the Reservoir

The pattern in all cases was the conventional 5-spot with the spacing between water wells ranging from 300 to 350 ft. For the Bradford sand the reported net sand thickness ranged from 17 to 55 ft. In the Allegany field, tests are being made in the Penny, Richburg, Scio, and Waugh and Porter sands. The sand thickness in these varies widely and in some instances as many as three separate sands are being produced through the same wells. In practically all cases the production is being pumped, although in at least one instance gas has been injected into a lease that is being produced by flowing.

In the Bradford Third sand the air permeability of some layers ranged as high as 225 md but in general averaged from 5 to 25 md. In the Allegany fields the air permeability of the sands averaged about the same as for the Bradford field sands and ranged from 2 to 160 md.

Oil and water saturations in the Bradford sands prior to gas injection were reported to average approximately 45 and 25 per cent of porosity. In one lease subjected to gas after flooding the oil saturation was estimated to be 45-50 per cent and the water saturation was possibly as high as 50 per cent. In the Allegany field sands the reported oil saturations ranged from 33 to 43 per cent and averaged 39 per cent of porosity. Water saturations were approximately 26 per cent. The sands that

†Presented at the Spring Meeting of the Eastern District, API Division of Production, Pittsburgh, Pennsylvania, April 2, 3, 4, 1952.

*Pennsylvania Grade Crude Oil Association Research Laboratory, Bradford, Pennsylvania.

were already depleted by water flooding before gas injection were indicated to contain approximately 30 per cent oil and 40 per cent water.

Some of the Bradford as well as the Allegany field sands showed some evidence of layers that are commonly called "water soaked", even on leases that were not as yet subject to intentional water flooding. This condition is generally attributed to old leakers or unrecorded "dump" floods.

Gas Injection

The gas injected was anything from dry gas to extremely wet lease gas, and was combined in all possible ratios. Generally, less than half of the gas injected was purchased, the remainder being produced on the same lease or another one belonging to the same company. Seldom was purchased gas injected into an entire lease before water was injected. Either the company had some excess lease gas from another project that was already producing, or the lease was developed in stages. That is, gas was injected into a portion of the lease and water turned in. The gas production from the producers on that portion would be collected and injected into another portion of the lease, and so on until the entire property had gas injected into it. Such a development program required a minimum amount of purchased gas and prevented an excess of "flush" gas.

Gas injection methods varied from single well operations to blocks of wells. The number of wells per block varied from 2 to 10, depending on the amount of gas available, pressure, compressor capacity, and the rate at which the wells would take the gas. On one lease where the wells took gas at low rates as many as 24 wells were being fed from one compressor. The general practice was to inject gas into a number of wells and watch the gas pressure on the producing wells that would be affected. The gas pressure would build up on the producing wells in anywhere from 2 to 70 days and most often showed up in two weeks. On the depleted properties the average time was somewhat greater. As would be expected from the extremely variable conditions in the reservoir and the methods of injection, the gas pressure increase in the producing wells varied widely. In some instances it went as high as 100 psig. If and when gas broke through, gas injection would be curtailed or stopped on these wells from which it was suspected the gas was coming. Thus an attempt was made to balance the gas injection by results at the producing wells. In general, care was taken to avoid an out and out gas drive. Present operations still follow this same practice.

Gas injection pressures varied from 100 to 500 psig for unflooded Bradford Third sand. In general, gas injection was begun at the lower pressure and then built up gradually to the top pressure of 500 psig. Pressures of from 550 to 650 psig were required to inject gas

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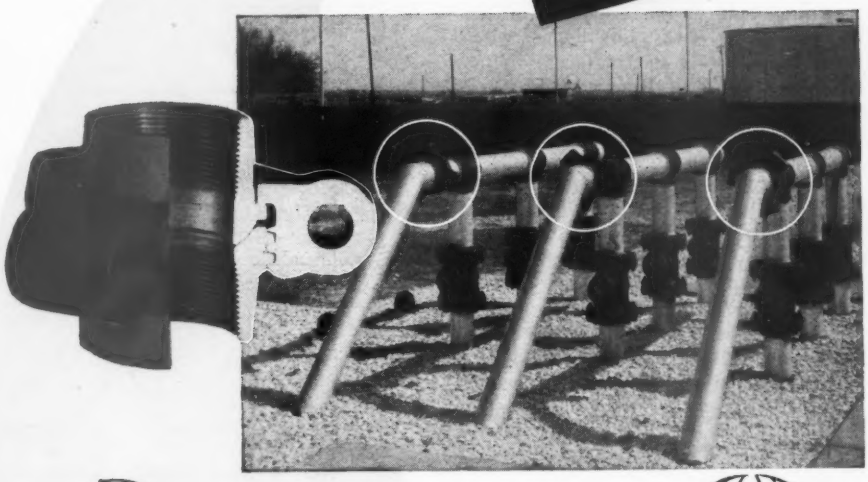

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into the Bradford sand that was already being water flooded. In the Allegany field gas injection pressures varied from 125 to 400 psig, with two operators injecting gas into the Richburg sand at pressures up to 750 psig. One of them used a pressure of 800 psig to inject gas into some depleted Richburg sand that was produced by flowing. As would be expected from the variation in permeability and injection pressures, the average rate of gas injection varied from 200 to 960 cu ft per day into the Bradford sand before flooding. The gas injection rate into sands already being flooded was only about half that into the unflooded sands. Injection rates into the Allegany field sands varied from 20 to 910 cu ft per day, which reflected the extremes in sand permeability and injection pressure. Gas injection into a flooded out Richburg sand of 0-17 md permeability averaged 140 cu ft per day.

The total amount of gas injected in the Bradford sand varied from 3600 to 8900 cu ft per acre per ft of sand and averaged approximately 6000 cu ft per acre per ft. That injected into Bradford sand already under flood averaged about 7000 cu ft per acre per ft. In the Allegany field the amount of gas injected varied from 1600 to 18,000 cu ft per acre per ft with no significant average being calculable. Apparently there was no other technical reason advanced for limiting the amount to be injected per acre except that of trying to avoid an out and out gas drive. Calculations based on a porosity of 16 per cent indicate than an average of 0.85 pore volumes of gas at atmospheric pressure were injected into the Bradford field leases on which there was no prior flooding. That injected into flooded leases was approximately 1 pore volume. For a 25 ft net sand reservoir of 16 per cent porosity that would be approximately 150,000 cu ft per acre. In the Allegany field the amount injected per acre actually varied from 35,000 to 400,000 cut ft.

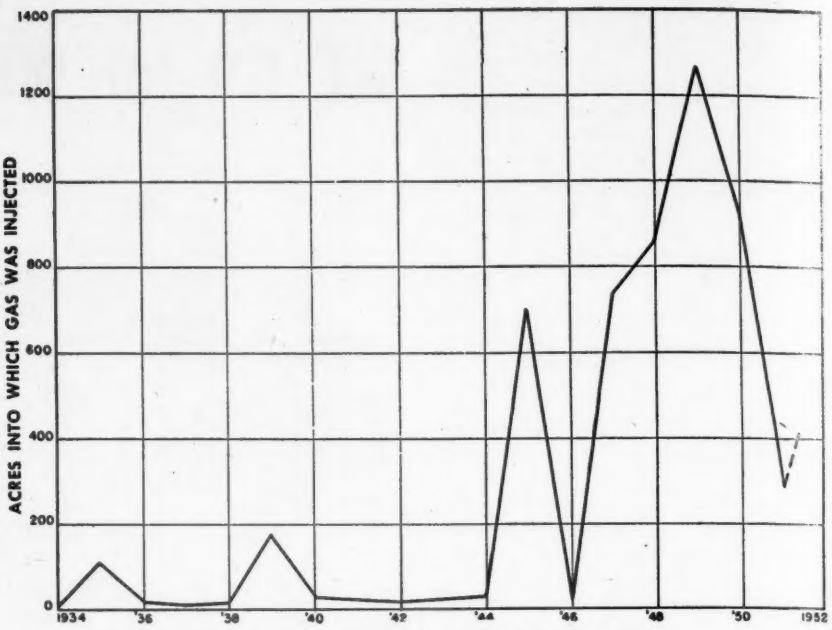

FIG. 1. Injection of natural gas before and during water flooding in the Bradford and Allegany Fields.

Wherever the figures were available, a survey was made of the costs of gas injection. It indicates that for labor, supervision, fuel, materials other than injection gas and depreciation, the cost ranged from 23 to 33 cents per 1000 cu ft. On large scale operations this cost will drop to only half that amount.

Water Intake After Gas Injection

From 13 producers who would volunteer some estimates of the effect of the gas injection on subsequent water intake rates, figures in Table 1 were obtained.

It was interesting to note that of the 10 instances where the water intake rate started or stayed above normal after gas injection, four were operations where water had already been injected for varying lengths of time before gas injection. On two Bradford leases into which gas was injected during flooding, the water intake rates started out higher right after the water was turned in again, then slowly decreased and leveled off at the rates which prevailed before gas injection. One Allegany field test showed the same results, and another shows the increased intake rate to be continuing.

A survey of the experience with gas injection on 76 leases in the Bradford and Allegany fields indicates that in no instance was there any difficulty in getting the water started in. In some instances there was some indication of a temporary plugging due to "Jamin action". This was evidenced by a slowly increasing intake rate which persisted anywhere from ½ to 6 months before it leveled off or declined. The reported increases varied from 15 to 100 per cent of the initial intake rate.

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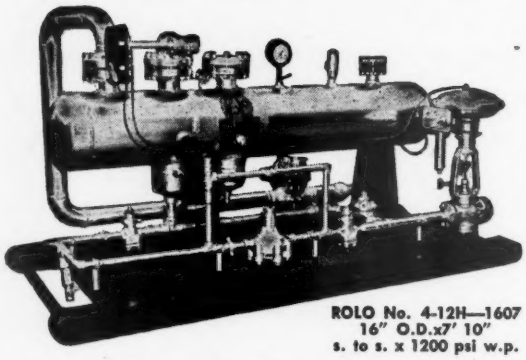

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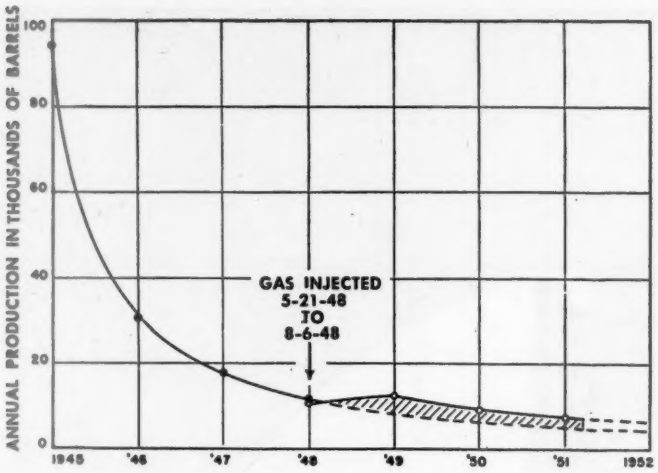

FIG. 2. Results of gas injection into a water flood project in the Bradford field.

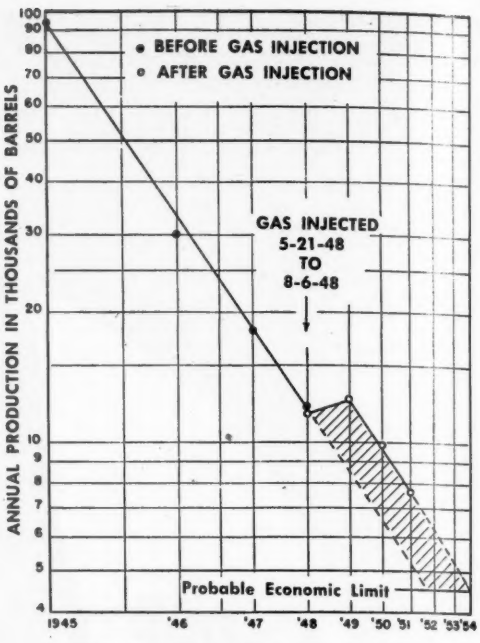

FIG. 3. Results of gas injection into a water flood project in the Bradford field.

Oil Production

Where gas was injected prior to flooding substantial oil production usually commenced from two weeks to three months after water injection began. Only two producers suspected that their production was delayed by gas injection after allowing for the time spent while injecting the gas. All but two indicated that in their estimation the production rose faster and peaked at a higher rate than they had anticipated. Most of the producers also reported that the peak production rate was maintained for a longer time than they had anticipated. Some indicated that when the decline came it was slower than they had expected.

Based entirely on opinion and production to date, seven operators in the Bradford field and four in the Allegany field believe that more oil will be produced up to the economic limit due to preliminary gas injection. The experience of these operators accounts for nearly 90 per cent of the acreage into which gas has been injected. Three operators whose experience with gas injection dates back 8 to 10 yr believe that from 10 to 15 per cent more oil was recovered due to gas injection before flooding.

Some information is available on eight experiments in which gas was injected into leases that already had been flooded for a number of years. In seven of the eight experiments increases in recovery rate were reported. The increase varied from 10 to 200 per cent of the rate that existed just before gas injection. In only one instance did the gas injection fail to increase the production rate. No instances were reported of a decrease in production rate caused by gas injection except for that that occurred during and immediately after the time in which the gas was injected.

Complete data and production rate curves were available on only two such experiments. Both occurred in the Bradford field and were performed by operators who had sufficient control over the tests so the data may be considered very reliable. One of the experiments was performed on a 104-acre lease that had been under flood for over four years before gas was injected. Two and a half years after the peak of oil production, gas was injected through the water input lines into the producing formation for a period of two and a half months. During that time a total of 10,755,000 cu ft of gas was injected at an average rate of 140,000 cu ft per day, and at a pressure of 450 psig. Approximtely 103,000 cu ft of gas were injected for each acre in the lease.

Figs. 2 and 3 are graphs of the oil production decline curve, one plotted on an arithmetic scale and the other on a log-log scale. It is rather obvious from a comparison of the actual production curve and the projected curve without gas injection that there was an increase in oil production rate. As there was no other change in the operation of the lease, it is believed that the greater oil production is attributable to the injection of the gas. After correcting for the loss in production while the gas was being injected, it can be estimated that the additional oil production from August 1948 to January 1952 amounted to 9000 bbl. The additional recovery up to the probable economic limit will be approximately 21,000 bbl, 9650 bbl of which is due to the two year extension in the economic life of the property. The economic gain as estimated from the calculations outlined in Table 2 amounts to about $38,821.50. This sum if realized will be a considerable return on an investment of only $8400. To this may be added the economic gain from the additional gas production that is being reported.

The other project on which comprehensive production data were available involved a 10-acre portion of a 30-acre lease that had been under flood for 3 years before the gas was injected. Approximately two years after the peak of production wet gas was injected into 4 water intake wells for a period of 6 months, and then the water was turned in again. A total of 3,782,000 cu ft of gas was injected at an average daily rate of 15,000 cu ft per well, and at a pressure of 530 psig. The gas injected per acre averaged 378,000 cu ft. Injection was occasionally interrupted because of cold weather and plugging off.

Figs. 4 and 5 are graphs of the oil production decline curve, one plotted on

TABLE 1. Effect of gas injection on water intake rate.

Effect Noted	Instances
Began below normal then rose to normal intake	4
Began at normal intake and continued at normal intake	3
Began at normal then rose to a rate above normal	7
Began at a rate above normal then declined to normal rate	3
Stayed below normal or decreased to below normal	1

TABLE 2. Calculation of economic gain by gas injection into a water flood project in the Bradford field.

Value of additional production		
11,800 bbl @ $4.00 per barrel		$ 47,200.00 (A)
Cost of gas injection		
10,755,000 cu ft of gas @ $450 per cu ft	$ 4,839.75	
Labor, supervision, fuel and miscellaneous @ $250 per cu ft	2,688.75	
Depreciation on compressor and other equipment	850.00	
Total costs		8,378.50 (B)
Net Gain (A) minus (B)		$ 38,821.50

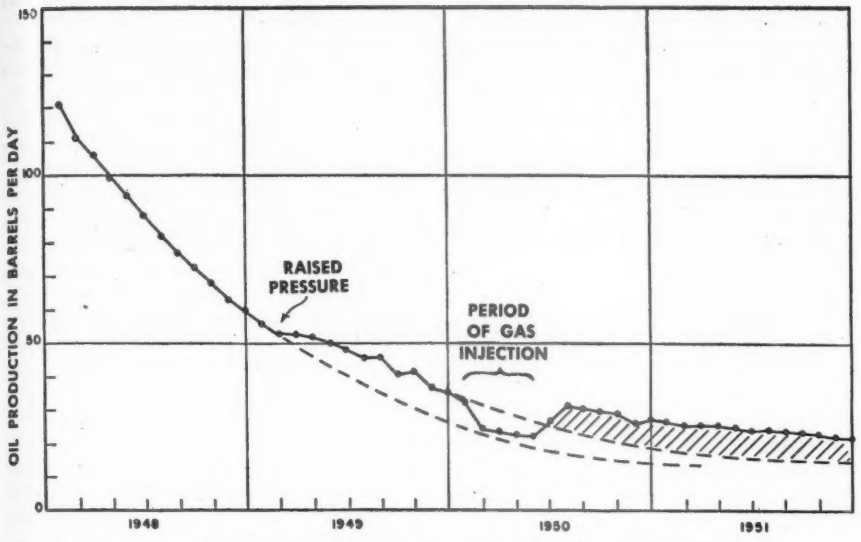

FIG. 4. Results of gas injection into a water project in the Bradford field.

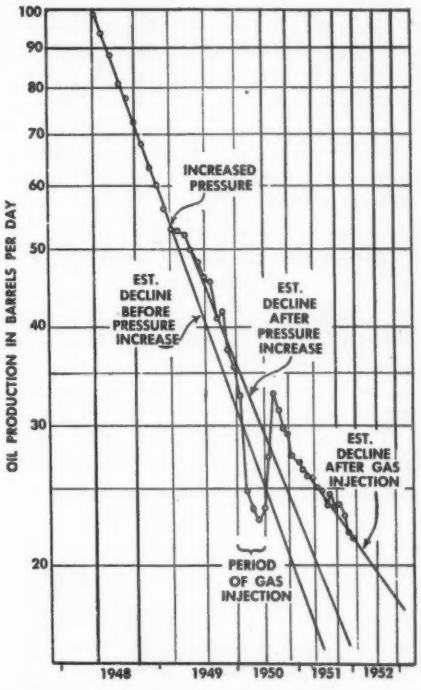

FIG. 5. Results of gas injection into a water flood project in the Bradford field.

an arithmetic scale and the other on a log-log scale. It will be noted that approximately one year before the gas was injected the water injection pressure was raised that shifted the decline curve and decreased its slope somewhat. During the period of gas injection oil production fell off sharply. When water injection was resumed oil production picked up again rather rapidly and rose to a new production decline curve with less slope. Where the production decline curve follows a straight line on a log-log plot, it has been demonstrated[12] that a sudden displacement or a sharp change in the slope of the curve will occur if there is some change in the operation of the flood. This is well illustrated in the production curves of Figs. 3 and 5.

From Figs. 4 and 5 it is apparent that the oil production rate was increased by the injection of gas. By estimating the area between the newest decline curve and the projection of the decline curve just prior to gas injection, it appears that up to January 1952 there has been a net increase in production of 3600 bbl of oil. This is after correcting for the loss of production during the period of gas injection. As estimated from the calculations outlined in Table 3, the economic gain up to January 1952, which is attributable to the gas injection, amounts to about $11,150. If one can assume that the economic life of the property will be extended because of gas injection, then the net economic gain will be somewhat greater.

In the Allegany field comparative data were available on only one project in which gas was injected into a water flood after it had already been under flood for a number of years. The test area was within a 68 acre lease that had been under flood for 12 years. For over a year before gas injection, clean-out work on input wells was resorted to in an attempt to increase production. It was partly successful in that it raised the production rate from 33 to 41 bbl per day. By April 1951, however, the production was down again to 32 bbl per day. That month gas injection was begun on 5 intake wells. The injection pressure started at 900 psig then dropped to 700 psig and an average of 300,000 cu ft of gas was injected into each well. During gas injection the production fell off to 25 bbl per day and when water injection was resumed, the oil production increased sharply and rose to a peak of 49 bbl per day. Between November 1951 and January 1952 the production was holding at the 44 bbl per day level, approximately 12 bbl per day higher than the production a year before. The average production for 1951 was 5½ bbl per day higher than for 1950 and the only material change in production practice was the gas injection. Thus it was estimated that the increased production has already amounted to over 2000 bbl of oil valued at $8000. The cost of injection including the gas was estimated at $1500, which indicates a net economic gain of $6500 already.

Gas Production and Utilization

In all but one of the projects reported on in the Bradford field a substantial increase in gas production was noted soon after the gas was injected. Similar results are reported for over half of the projects in the Allegany field. This increased rate of gas production persisted after the water was turned in, and was maintained almost indefinitely. In some instances it has already lasted for years. There was also reported a considerable increase in the Btu value of the gas. Those operators who have made some measurements of the cumulative volume indicate that after deducting the volume of gas injected, the net gas production was two to four times that which could normally be expected from the oil production on such leases. Such results do not appear logical but the fact remains that nearly all operators made such reports. A number of them illustrate it by a comparison of gas bills before and after gas injection. For example, one of them reports that before gas injection his gas bills averaged $280 to $300 per month. For the six months that have elapsed since gas injection his gas bills have averaged from $50 to $86. He estimates that he paid $1300 less for gas during the past six months because of the increased gas available on the lease. Considering that he injected only $675 worth, he figures that he is already $525 ahead.

On one project in the Bradford field where gas was injected after flooding was already in progress for three years, the gas production is still coming up steadily 1½ years after gas injection. Unfortunately no attempt is being made to determine how much of the injected gas is being recovered.

In nearly all cases where there is surplus gas it is being re-injected on the same lease or on another one belonging

TABLE 3. Calculation of economic gain by gas injection into a water flood project in the Bradford field.

Value of additional production (to January 1952)	
3600 bbl @ $4 per barrel	$ 14,400.00 (A)
Cost of gas injection	
3,782,000 cu ft of gas @ $400 per cu ft	1,512.80
Labor, supervision, fuel and miscellaneous @ $410 per cu ft	1,565.51
Depreciation on compressor and other equipment	300.00
Total costs	$ 3,378.31 (B)
Net Gain (A) minus (B)	$ 11,021.69

to the same company. In this way gas is conserved so that a sufficient amount will be available over the entire economic life of the property. Most producers maintain that if there were no other advantages to gas injection in water flooding, the economic benefits of gas storage and multiplication alone would justify gas injection.

Properties of Crude and Effect on Paraffin

In answer to the question, "Was there any noticeable change in the properties of the crude" due to gas injection, the majority response was the crude was much livelier and somewhat lighter in color, the lighter color possibly being due to the heavier gas blanket that shielded the crude from air and prevented it from becoming oxidized.

On none of the projects was there any paraffin trouble that could be attributed to gas injection. A number of operators indicated that there was less paraffin, or if there was any change the paraffin was eliminated. A few operators in the Allegany field reported that the livelier crude and extra gas helped to clean out their producing wells and thereby stimulated production.

General Discussion

All 14 of the producers interviewed were of the opinion that gas injection ahead of water flooding is generally applicable and worthwhile. Those who have been able to give it a reasonable trial are certain that they have benefited by it in one way or another. Besides the advantages of increased oil and gas production, such benefits as increased water intake rates, more balanced (efficient) flood, decreased wax problems, etc., are reported. Some feel that the temporary plugging action of the gas in the more permeable sand layers helps to get the water started into the less permeable sand and thereby creates a more uniform oil bank. One producer even reported the discovery of three abandoned wells on a property which has had high pressure water on it for years. Where water has already been injected, the additional gas is expected to produce more oil by increasing the free gas saturation, improving the mobility of the oil, and by solution of interstitial paraffin.

In response to the question, "Do you believe gas injection could possibly do any harm" the answer invariably was "no". Those who qualified their answer gave the following reasons by way of explanation:

The dry gas may strip off the light ends of the crude and make it more difficult to move because of increased viscosity or wax precipitation in the formation.

The gas drive may reduce the oil saturation to a point where the water will not start an oil bank later on.

The increased gas saturation will cut the rate of oil productoin. The gas, if injected into low permeability sand will plug it by a Jamin action.

If it is injected into a high gas saturation sand, it will deplete the sand by gas drive and render it unfloodable.

It is very dangerous to fool around with high pressure gas in ordinary lease lines.

This last remark is serious and deserves some elaboration. Most water flood operating personnel have had little or no experience with the handling of high pressure gas. Many have been using as low as 250 psig test water service pipe and fittings on their leases carrying as high as 1200 psig water pressure. A break in such a water line ordinarily would not harm any persons who happened to be nearby except for a wetting. A blow up in a high pressure gas line or fitting is the equivalent of an explosion — which may mean flying metal. The recommendation therefore is that anyone who contemplates the injection of high pressure gas into lease lines should proceed with care, and entrust such operations only to those who would show the proper respect for the dangers involved.

Where there is danger of freeze-up in the lines it has been found advisable to use some anti-freeze in the gas. Gas injection should take place preferably in the summer when there is less danger of freeze-up. Also, gas is more available in the summer and often a special price advantage can be had.

1951 Well Completions Are Highest in History

It is estimated that about 44,500 wells were drilled in the U. S. in 1951. Of these, about 23,500 produced oil and 3000 found gas. Total completions in 1951 set a record high, and were about 1000 over the 1950 figure. Even more wells would have been drilled had it not been for the restrictions placed on the industry by lack of steel.

Acknowledgments

The author is grateful to the following companies and persons who so generously provided the information from which the paper was compiled: South Penn Oil Company, Kendall Refining Company, Smith-Newton Oil Company, Bradley Producing Company, M. D. Booth Oil Company, The Thornton Company, L. G. Lent, A. E. Booth, J. C. Stengel, Howard Platt, and John DePetro.

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After the first show, on wildcat wells, the usual procedure is to drill ahead to total depth, rathole coring after each good mud logging show, followed by testing and reaming as necessary. In some circumstances, as in development wells on the east side of the Basin, continuous full hole diamond coring and testing of the Lower Green River pay zone is generally adopted for reasons of economy. Spot cores are usually taken when penetrating the Wasatch, although a deep well on the west side was continuously diamond-cored with a reported appreciable saving in trip time and bit cost over normal drilling. Mud characteristics usually fall in the following ranges, depending on the depth of drilling and the area: Wt. 8.6 to 10.5 lb per gal, viscosity 38-60 sec., W. L. 15 to 3 cc, pH 7-9.5.

Drilling weights on the bit are generally gradually increased with depth from 4 tons to 10 tons at ±4500 ft and on up to as much as 20 tons at ±9000 ft. Rotary speeds are correspondingly decreased from ±150 to ±60 rpm. Drilling records during the past year have confirmed the previously established belief that drilling weights in excess of 25,000 lb on 9-in. bits give substantially increased penetration rates over those obtained by weights of 10,000 lb or less.

Drilling progress to the top of the Green River formation compares with shallow drilling in other areas of the Rocky Mountains. Progress from this point on is impeded by lower penetration rates, however, due to hard abrasive rocks, as well as by lost circulation and, of course, time spent in coring, reaming, and testing.

When drilling zones of serious lost circulation that cannot be readily healed by the aforementioned practices, spotting of cement or diesel oil-gel plugs has been practiced with some success. A homemade plug made of torn strips of paper mud sacks, which is pushed ahead of the bit, has also been used with favorable results. Lost circulation time per well generally varies over the range of 2 to 7 days.

Coring programs consist generally of spot coring with 6 to 6¼-in. diamond heads possible shows in the Upper and Middle Green River, and continuously rathole coring and reaming, or full hole coring with 8¾-in. to 9-in. bits, the Lower Green River pay zone. Spot coring is resumed in the Wasatch formation. Fifty foot core barrels are in most common use, although some longer barrels are used. Core recovery is approximately 99 per cent. Salvage value of the heads is approximately 60 per cent. Cored intervals are usually analyzed on or near the location by mud-logging units. Core analysis does not always provide a complete definition of producible fluids and drillstem testing of all or part of the cored intervals is a common practice in order to confirm or further evaluate the shows.

Drillstem testing follows normal procedure except that more than usual at-

The Author

E. N. Dunlap is division petroleum engineer, western division, in Denver, Colorado for The California Company. A graduate of Texas University, he joined Humble Oil and Refining Company in 1933, leaving in 1934 to do graduate work at MIT where he received his MS and ScD degrees. He was employed by Standard Oil of California in 1937 where he worked as production engineer in the Los Angeles Basin until 1942 when he transferred to the Houston office of Standard Oil (Texas). In 1947 he was sent to California Research Corporation as senior research engineer in New Orleans acting as liaison between The California Company and research organization. For three months he was loaned to Arabian American Oil Company for an engineering study in Saudi Arabian fields.

He went with The California Company in 1950 and was appointed to his present position in April last year.

*Presented before the Rocky Mountain Association of Petroleum Geologists, February 28-29, 1952, Salt Lake City, Utah.

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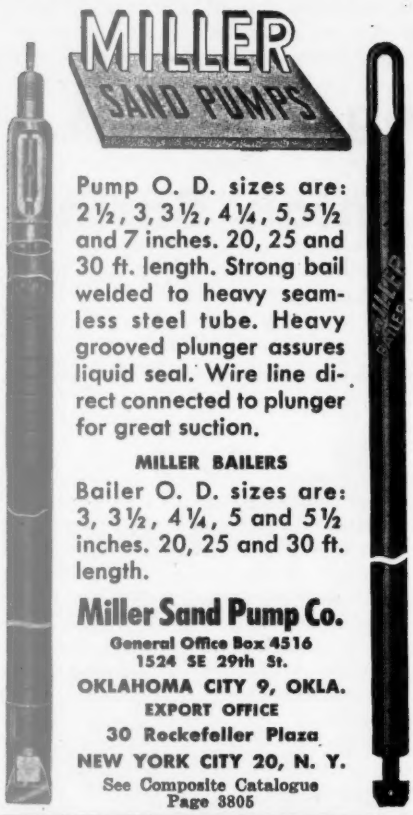

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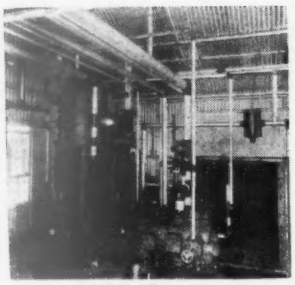

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tention is given to selecting packer seats that are without fractures and steps are taken to minimize chances of plugging of anchors and tools by lost circulation material. Single full hole packers with jars, safety joint, and drill collars are usually used. Double packers are used in the deeper wells, particularly in the Green River-Wasatch transition zone and in the Wasatch. Water cushions are generally used below about 8000 ft. A bottom hole choke is occasionally used but most often is omitted unless gas is expected. Flow behavior during drill-stem tests is sometimes erratic. It is occasionally difficult to differentiate the effects of partial plugging of the tool from gelling of the viscous oil in the drill pipe when a surging blow occurs or pressure heading is noted on the chart.

High Pressure Zones

Generally formation pressures in the Tertiary section are less than the equivalent hydrostatic head reckoned from the surface to depths as low as 6000 ft. Below this depth, occasional zones of high gas pressure have been encountered, but so far they have given no serious trouble. On one well it was necessary to maintain a mud weight of 13.6 lb per gal and any variation of more than 0.2 lb per gal would either cause loss of mud or the well would kick. Fortunately this case is not the rule.

Crooked Holes

Except in one or two wells drilled in fault zones on the west side of the basin, no difficulty has been encountered in keeping within the usual allowance for drift, even with increased drilling weights now maintained. One well was drilled in a faulted area to approximately 2750 ft, plugged back and sidetracked in an effort to straighten the hole. After reaching the previous total depth, the deviation had again increased to above the usual allowance.

Completion Practice

The procedure used in completing wells varies between the east and west side of the Basin, reflecting the predominating producing characteristics of the pay zones. On the west side, where fracturing predominates, 7-in. casing is set on top of the first good show and several hundred feet of open hole is left exposed. On the east side where bedded sands and siltstones predominate over fractures, 7-in. casing is generally set through the Lower Green River pay zone and the more promising shows are gun perforated with a combination of bullets and shaped charges. This method of completion is favored because of the presence of intermediate gas and water zones. The wells are completed with 2½-in. tubing and swabbed into production.

Stimulative Treatments

The following stimulative treatments have been applied to wells after completion: Acidizing, Hydrafrac, oil squeeze, nitro shooting, and emulsion breaker. Of these, only acidizing and oil squeezing have shown definitely favorable results. Acidizing of partially calcite lined fractures has been successful in several wells on the west side. Other wells in that area and on the east side have not similarly responded. There is some reason to believe that the percentage of success with acid would have been higher had mechanical conditions in every case permitted thoroughly precleaning the well bore of mud before acidizing and rapid removal of spent acid from the formation after acidizing. Oil squeezing has been helpful in one out of three wells in which it has been tried on the east side.

Fishing

Fishing jobs normally encountered in drilling, i.e., for twisted off drill pipe, parted core barrels, and lost cones have offered no serious difficulties in view of the stable hole drilled through hard formations. These jobs are completed relatively promptly by the use of overshots, diamond washout shoes, and junk baskets, etc. Some complications have arisen, however, in highly fractured and shot sections.

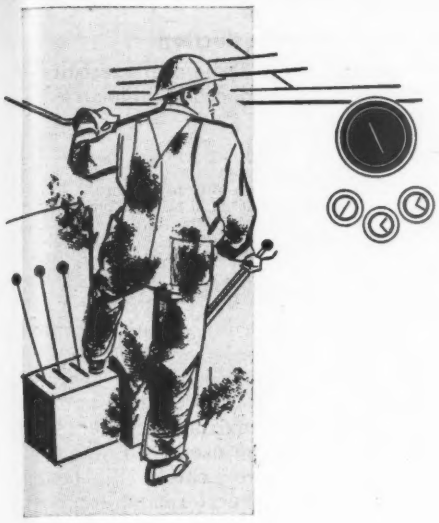
Logging

Generally, most logs having prospective value are run at total depth and/or before setting the oil string. In addition, electric logs are run near the top of the Lower Green River pay zone for correlation. Logs used are: Electric log, microlog, gamma ray, neutron, caliper, and temperature. Both electric logs and gamma ray-neutron logs are run for correlation and determination of lithology. The microlog is helpful in indicating intergranular permeability and Caliper logs have been reported to be helpful in locating fractured zones. A break in the temperature gradient has been found to correlate with the top of the pay section in some areas.

The logs employed to date have not permitted prediction of the type of producible fluid with a satisfactory degree of regularity. Inasmuch as predictions of producible fluid from core analysis have not always been the complete answer in this area, it may be expecting too much to hope for a logging technique that will do any better. To the mind of the author, the Lower Green River section offers serious obstacles to reliable prediction of producible fluid content from conventional electrical logs alone. These are: Prevalence of fractures, low and apparently wide variation in salinity of formation water, and the wide variation of lithology over very short vertical distances.

Special Muds

Two wells on the west side of the Basin have drilled the Lower Green River and Upper Wasatch formation with lime base-oil emulsion muds in an effort to improve penetration rate. The operator is not certain that its use has proved economical, however. A low



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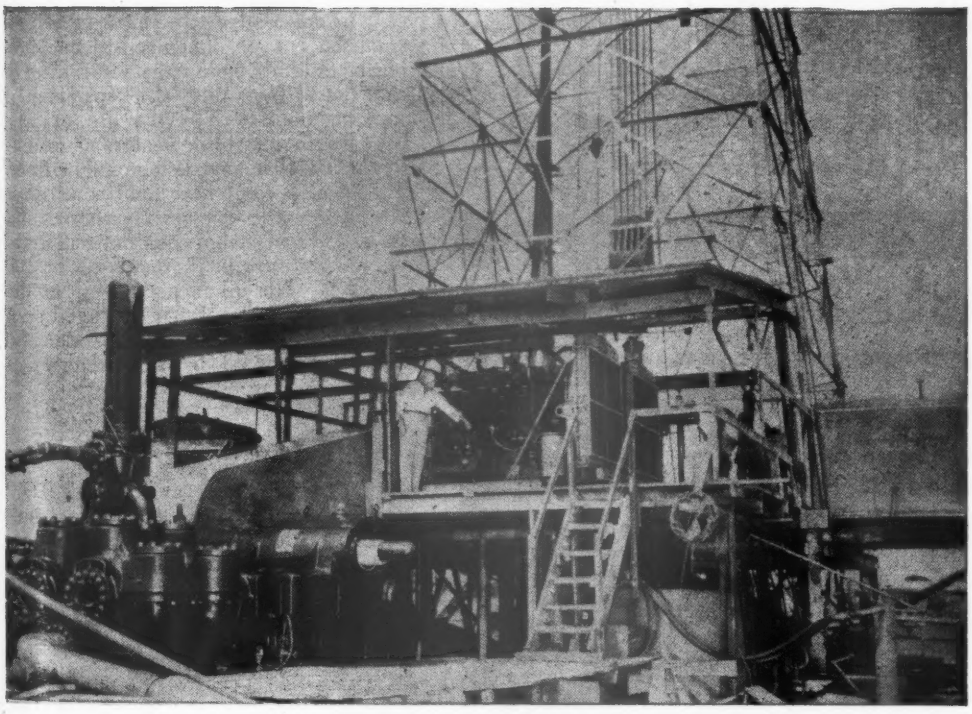

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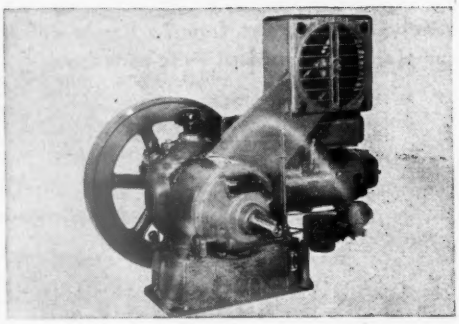
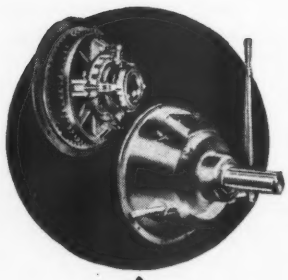
water loss lime base mud was used on another west side well in an effort to provide a thin acid-soluble filter cake while drilling the fractured section. It appears doubtful that this mud performed the job for which it was primarily intended.

One well on the east side used a low water loss lime-base oil-emulsion mud for drilling into the pay zone and deepening into the Wasatch. The operator is not convinced that this mud proved superior to normally used low water loss red mud in its effect on the pay zone.

There is some evidence that the low water loss red mud currently used in coring the Lower Green River siltstones and sandstones on the east side, may be causing a substantial reduction in drillstem test recovery as well as initial productivity. A well diagonally offsetting another well previously cored with red mud, was cored using burner fuel. The well cored with red mud was completed by setting 7-in. casing through the pay and perforating with 6 bullets and 6 jets per foot. The well cored with oil was completed barefoot. Productivity index tests on each well immediately after cleaning up showed that the one cored with red mud suffered a 50 per cent reduction in productivity on a comparable millidarcy foot basis. As additional locations, favorable for coring with oil, are drilled, this operator expects to give the procedure further trials.

Diesel Power Units Use





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Production

Quality of Oil—The characteristics of the crude oil produced is summarized as follows:

Gravity	29 - 42 API
Pour Point	80 - 110 F
Wax	10 - 50% by volume
Viscosity	120 - 190 SSU at 100 F
Sulfur	0.03 - 0.10%
Gasoline	15 - 18%
Kerosine	3.5 - 11.5%

Pumping Methods

Hydraulic downhole pumping units are in use in the deep wells on the west side. Free pumps operated by parallel strings are set just above the pay zones at depths of approximately 9000 to 9600 ft. The first pump installed has now operated for approximately 10 months with satisfactory performance reported by the operator. Surface lines are kept practically wax free by gas-fired indirect flow line heaters and the circulation of hot power oil into the well prevents wax accumulation in the parallel string. If it is desirable to shut in the well, all lines are kept unplugged by circulating oil through the well with the pump removed.

Pumping on the east side from 5500 ft wells is being done by conventional rod pumps. Paraffin scrapers are attached to the rods which are rotated a fraction of a turn during each stroke. No difficulty with hard paraffin caking on the rods has been reported and, except in one well producing with a high emulsion cut, no difficulty has been reported in starting up the units after a shut down. Flow lines are kept clear of wax accumulation by the use of gas-fired indirect flow line heaters as well as by the use of steam tracing on flow lines.

The oil is kept in a fluid state after it reaches the gas-oil separator and stock tanks by steam coils that maintain the temperature in those vessels at 100 to 120 F. The oil is picked up in the field from stock tanks by insulated tank trucks and carried either to the Rangely pipe line terminal or to the refinery at Salt Lake City.

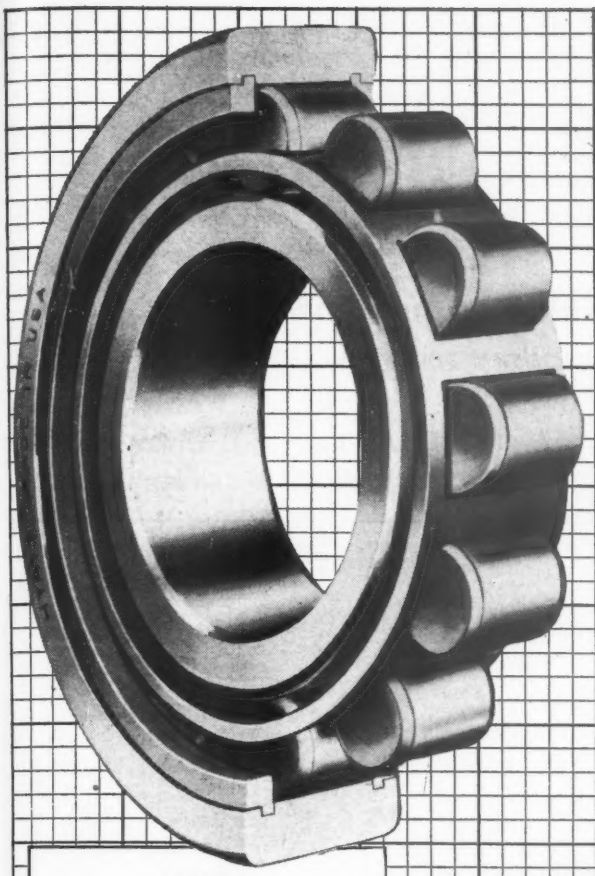
Costs

The costs of completed pumping wells producing into tanks vary from $170,000 to approximately $450,000. A great proportion of the well cost results from expenditures other than for making hole and equipping the well, as indicated by an estimated breakdown of rig time:

Rig Activity	Per cent of Time
Normal drilling, including trips	44
Coring and reaming	16
Testing and logging	13
Lost circulation	6
Fishing	1
Circulating samples, mechanical downtime	7
Casing, running casing, WOC	13
	100

It is clear that with high well and producing costs, there is a definite challenge to technical personnel to improve continually present methods as well as to try promising new equipment and techniques in an effort to reduce costs and enhance the development economics of this new oil province. * * *

To obtain more information on products advertised see page E-51



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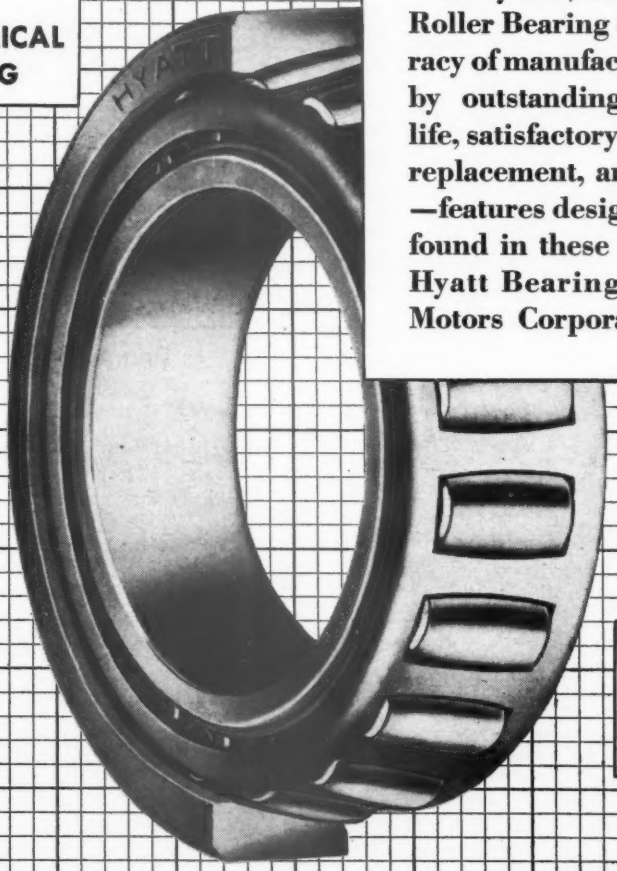

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PART 2

Economic Advantages of Unitization†

This concludes a two-part paper, which is a comprehensive study of primary and unitized secondary recovery results

BRUCE A. LANDIS, JR.* and L. E. BROCK*

Unit "B"

A step in the right direction is Unit "B", where quite a different situation is present from the standpoint of both the magnitude of the unitization program and the method of procuring the additional recovery. The analysis of the Unit "B" reservoir showed that competitive primary producing operations could be conducted for seventeen years after 1950 before the economic limit of production would be reached. But this analysis also showed that in an additional thirteen years the ultimate oil recovery could be increased 60 per cent with a unitized dispersed type gas injection program.

The reservoir is an elongated, bidomal, east-west trending anticline, and Fig. 5 in an idealized cross-section of the pay zone along the axis of elongation. There do not appear to be any communication barriers existent within the pay and the permeability is quite uniform. Permeability conditions are such, however, that it is necessary to acidize the Permian dolomite to obtain production.

Initial discovery in the pool was in 1944, and the pool productive limits were extended in 1946. By January of 1949 there were 116 wells on 40-acre spacing producing 8600 bbl of oil per day by artificial lift. Small amounts of water are produced with the oil in some portions of the field but no uniformity of water table has been found. It has been concluded, in view of the production history of the pool, that fluid expansion and dissolved gas are the sole sources of reservoir energy. The oil is especially characterized by having an abnormally low solution gas-oil ratio of only about 150 cu ft per barrel.

After comprehensive engineering and economic studies the area shown in Fig. 6 was selected for unitization. About 7500 surface acres are included within the unit area, representing 72 separately owned tracts. Eight working interests and 231 royalty interests were combined to effectuate the formation of the unit.

The decline curves shown in Fig. 7

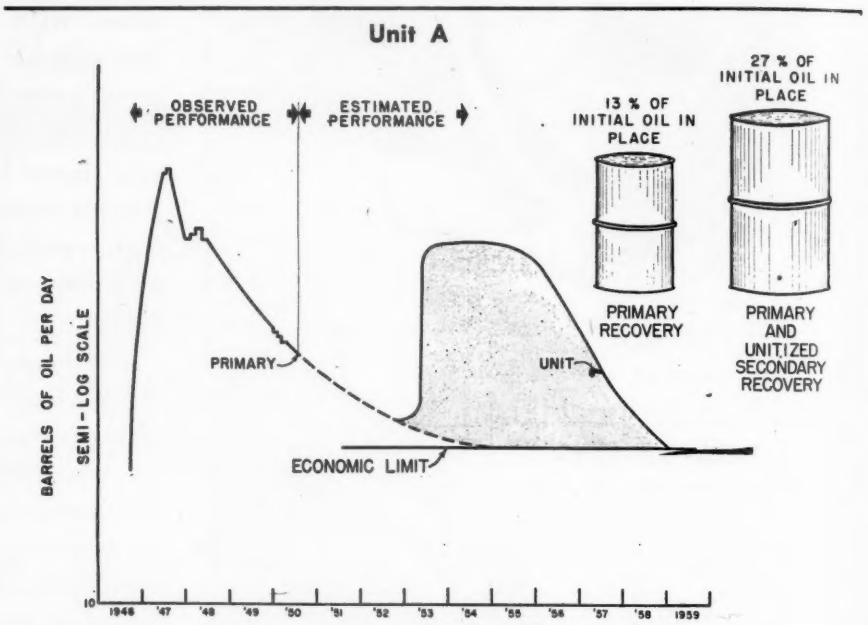

FIG 3. Primary field and unit field decline comparison.
(This replaces Fig. 3 carried in Part 1, which was wrong figure.)

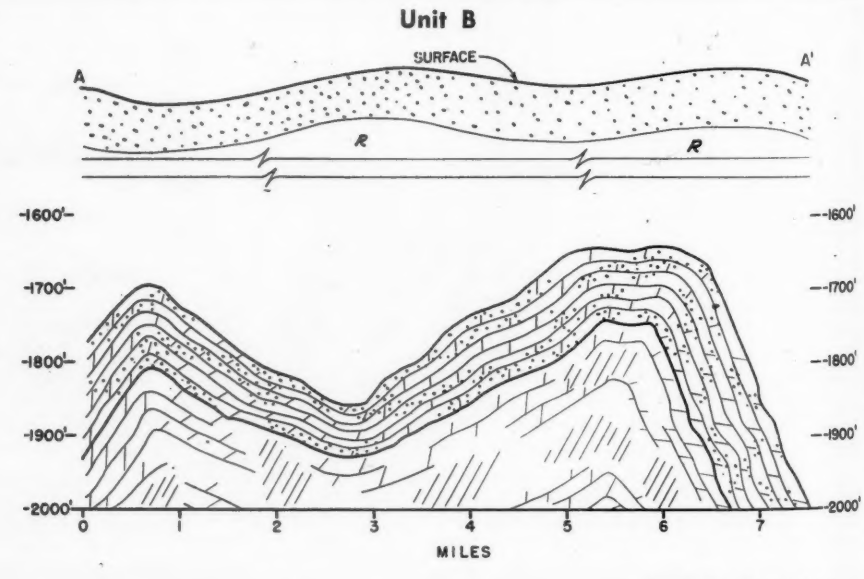

FIG. 5. Cross section—Unit B.

†Presented before the North Texas Oil and Gas Association, Wichita Falls, Texas, March 29, 1952.

*Unitization section, Stanolind Oil and Gas Company, Tulsa, Oklahoma.

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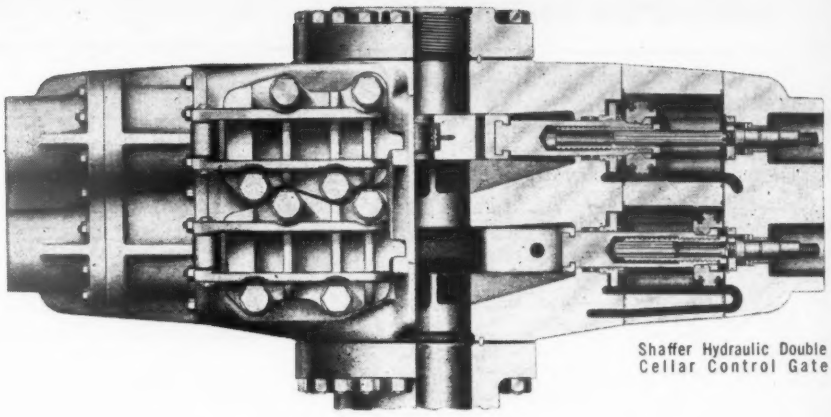

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Cellar Control Gates are an item you don't buy every day. That's why it's so important that you double-check the equipment you buy to make certain it has all the features essential for today's drilling operations.

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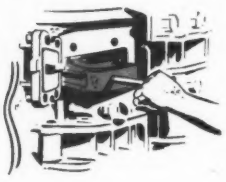
and, of course, that is the MOST important single item. In Shaffer Hydraulic Cellar Control Gates you get safety backed by the organization that pioneered cellar control gates well over a quarter-century ago. But look deeper than safety alone . . .

Look for COMPACTNESS!

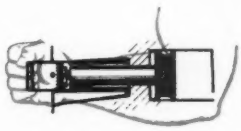
Equipment that is bulky and excessively large can take a high toll in greater rig costs, deeper cellar requirements, cumbersome hook-ups. But Shaffer Hydraulic **Double** Cellar Control Gates (**two** ram compartments unitized in **one** body) require only 30" total height even in sizes as large as 13⅜" (12" Series 900). Shaffer Hydraulic Single Cellar Control Gates require only 18½" in the same size. **Compare these compact dimensions with any other gate of comparable size and rating!**

Look for EASY RAM CHANGE!



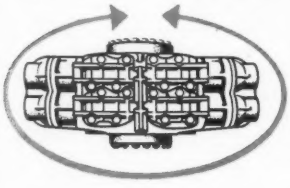
Rams must be changed frequently to meet requirements of varying pipe sizes as wells are drilled. In Shaffer Hydraulic Gates you simply open two doors in the side of the body, slide out the ram assembly, change rams, slide the assembly back in place and bolt the doors. **And complete ram changes can be made with equal ease whether the pipe is in or out of the hole!**

Look for SIMPLE DIRECT DRIVE!



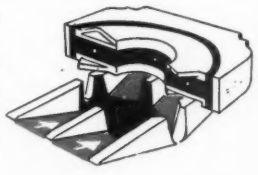
Note how Shaffer Hydraulic Gates have no complicated hook-ups or secondary connections between rams and operating cylinders. Operating pistons are **directly behind** the rams for direct fool-proof drive, fewer parts, positive simplicity!

Look for ENCLOSED DESIGN!



There are no exposed moving parts in Shaffer Hydraulic Cellar Control Gates All operating members are enclosed within the gate body—protected from corrosive muds, from jamming by loose timbers, from abrasive grit and sand!

Look for MUD-FREE DRAINAGE!



No detrimental mud accumulations can interfere with free ram travel in Shaffer Gates because the rams move on high narrow guide ribs above the steeply-sloped ram compartment bottoms. Mud and sand quickly drain back into well—rams are always ready for use.

These and many other features make Shaffer Hydraulic Cellar Control Gates the outstanding choice of leading operators. Compare, point-by-point, and you'll see why! Your nearest Shaffer representative will gladly supply complete details on Shaffer equipment. Or write Djrect!

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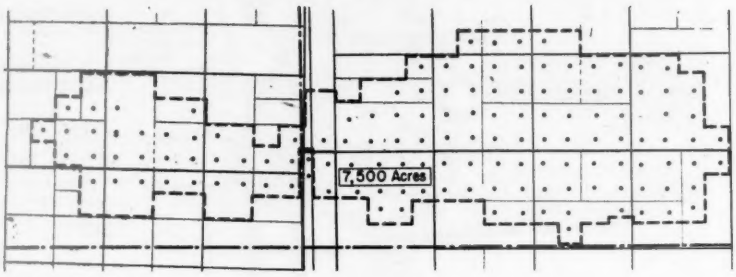


FIG. 6. Unit B.

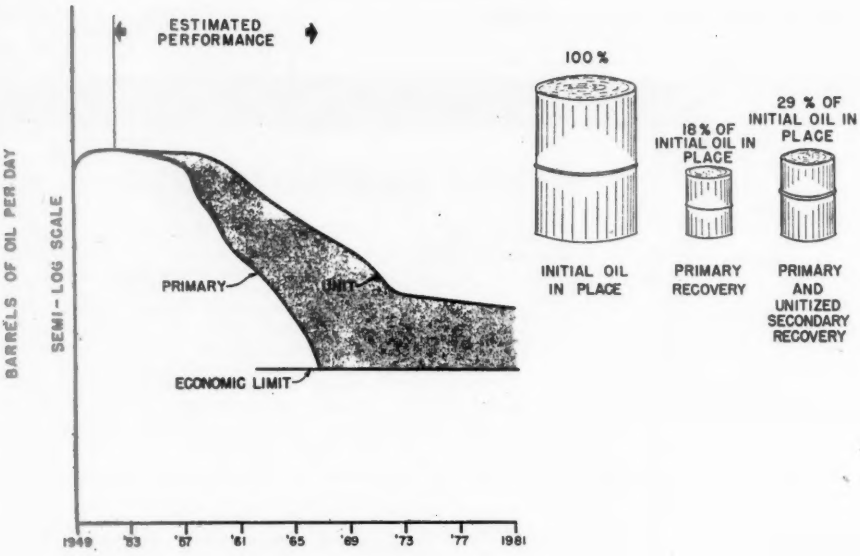


FIG. 7. Primary field and unit field decline comparison.

will illustrate the expected advantage of unitized gas injection over primary depletion; about 18 per cent of the initial oil in place would have been produced by 1967 (the abandonment date) under primary depletion. On the other hand, with the unitized gas injection program now in operation, an additional 11 per cent of the initial oil in place will have been produced by 1981. The total recovery with this program will be about 29 per cent of the initial oil in place. Doubtless too, before the field is finally abandoned, some other form of secondary recovery will be applied to the field in an attempt to reduce the estimated 71 per cent residual saturation to a lower figure.

To summarize the economics of competitive primary and unitized gas injection operations for Unit "B" see Fig. 8. The expected gross revenue after January 1950, with unitized gas injection, exceeds that for primary competitive operations by a ratio of 1.84 to 1, an increase of 85 per cent.

Fig. 9 shows net profit, before income taxes, after January 1950 for unitized gas injection to be in excess of that for primary competitive operations by a ratio of 1.74 to 1. This is a 74 per cent increase. To obtain this 74 per cent increased profit a total capital investment of less than 2½ per cent of anticipated increased profit was required initially. Ultimately this may be increased to slightly in excess of 7 per cent.

To present a comparison of cooperative or competitive secondary operations with unitized secondary operations would require a report in detail beyond the scope of this discussion. In the light of past experience, however, the benefits of the unit program as outlined for Unit "B" would appear to exceed materially any benefits to be gained by competitive secondary operations. One reason for this is that individual secondary programs would probably not have been instigated until at or near the primary depletion stage, at which time the reservoir pressures would have dropped so far below the bubble point pressure of 845 psia that many of the lighter hydrocarbons would have been separated from the oil in the reservoir, causing oil to be lost through shrinkage. Also, the oil viscosity would increase materially and this would require additional investment to obtain production and there would be less hope of profitable recovery.

This Unit "B" is admittedly a petroleum industry undertaking of large magnitude. Millions of dollars and millions of barrels of oil are involved, but this is by no means an indication that we have reached the pinnacle of achievement. Some really "big timers" are in the formative stage at this very moment. One of these, encompassing more than 50,000 oil productive acres, has set its sights toward an additional oil recovery of more than 700,000,000 bbl, which is at least a 125 per cent increase over primary competitive recovery. The economics of such a program will be reckoned in the billions of dollars.

Unit "C"

Unit "C" was formed for the reservoir, the pay zone of which is shown in cross-section by Fig. 10. An upper and a lower pay of Pre-Permian fractured chalky chert and lime are separated by a dense zone of impermeable limestone. Water-oil contact on the west, a fault on the south, a porosity pinch-out on the north, and truncation on the east define the productive limits. The degree of the producing formation dip indicated that it was feasible to attempt the formation of a secondary gas cap at the top of the structure which would effect down dip migration of oil to wells lower on the structure.

The crude is characterized by a high solution gas content of about 1200 cu ft of solution gas per barrel of oil, which

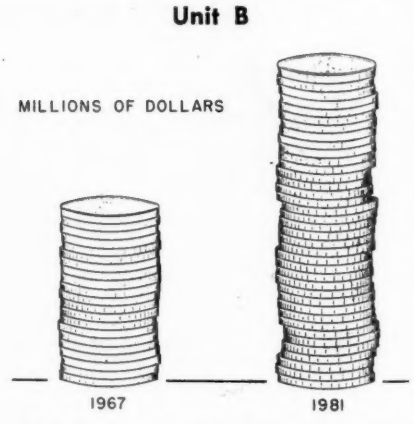


FIG. 8. Revenue from primary and unitized secondary operations—Unit B.

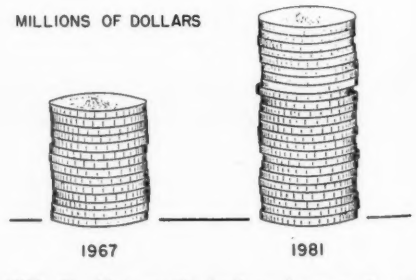


FIG. 9. Net profit before income taxes for primary and unitized secondary operations—Unit B.

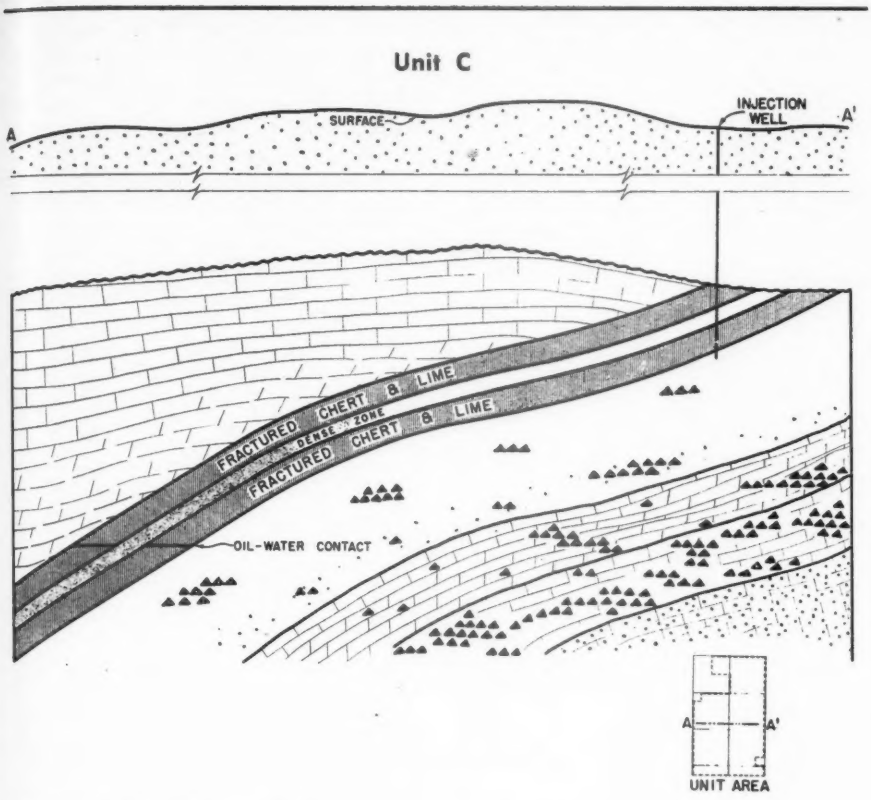


FIG. 10. Cross section—Unit C.

will provide more than sufficient gas for the formation of a gas cap.

An area shown in Fig. 11 comprising about 3700 acres, consisting of 14 separately owned tracts controlled by three operators, was unitized. The operators of an area contiguous to the unit, as shown by the figure, will cooperatively inject gas with the unit—a practice that detracts considerably from the over-all picture of benefits which could have been derived if this contiguous area were included within the unit; but since it was not possible to unitize the entire area, the next best thing was done, and some injection cost reduction will be possible through use of the common facility.

Fig. 12 shows the bottom hole pressure decline of primary operations as compared to unitized secondary recovery operations. The pressure maintenance will ultimately allow about 36 per cent of the initial oil in place to be produced. Were the portion of the field within the unit permitted to decline at its natural rate, only 23 per cent of the initial oil in place would have been produced. With 75 per cent of the produced gas returned to the reservoir, the 36 per cent of the initial oil in place estimated to be produced by the time bottom hole pressure is 300 psia is a recovery increase of 55 per cent.

Revenue and profit comparisons for the two foregoing units have already been shown and will not be dealt with for Unit "C"; however, the cooperative gas injection program with the area north of the unit will be discussed.

As pointed out previously the injection facilities can be installed and used at reduced cost because the costs will be shared by the unit and those conducting the program on the north, but total field operating costs will not necessarily be decreased. The reservoir will not necessarily be depleted as efficiently as it would be if the entire reservoir were unitized. Independently conducted injection programs do not permit the control of fluid movement essential to ensure the maximum ultimate recovery. When the only requirement is that a predetermined minimum amount of gas be injected into each of the separate gas injection areas, a large amount of oil may possibly be left in the reservoir. The maximum recovery from the reservoir can be attained only if the injection wells are positioned on a fieldwide basis where the injected gas will exert the fullest effect on movement of fluid in accordance with natural pressure gradients.

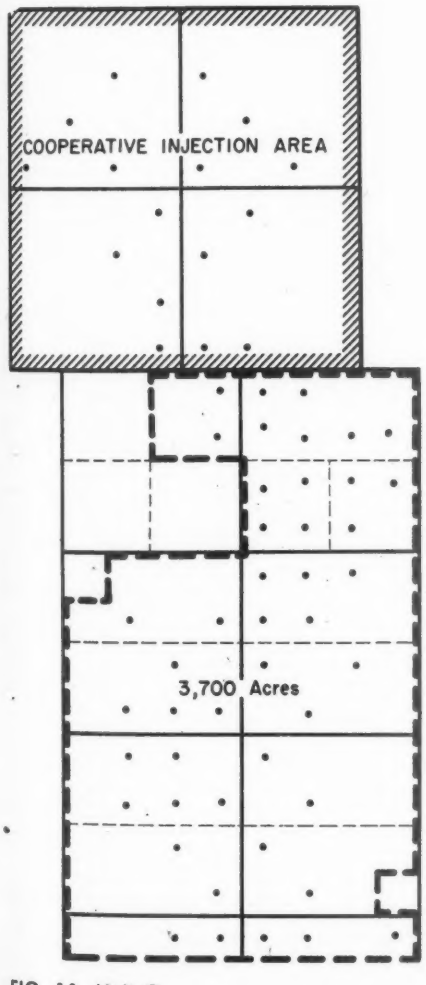


FIG. 11. Unit C.

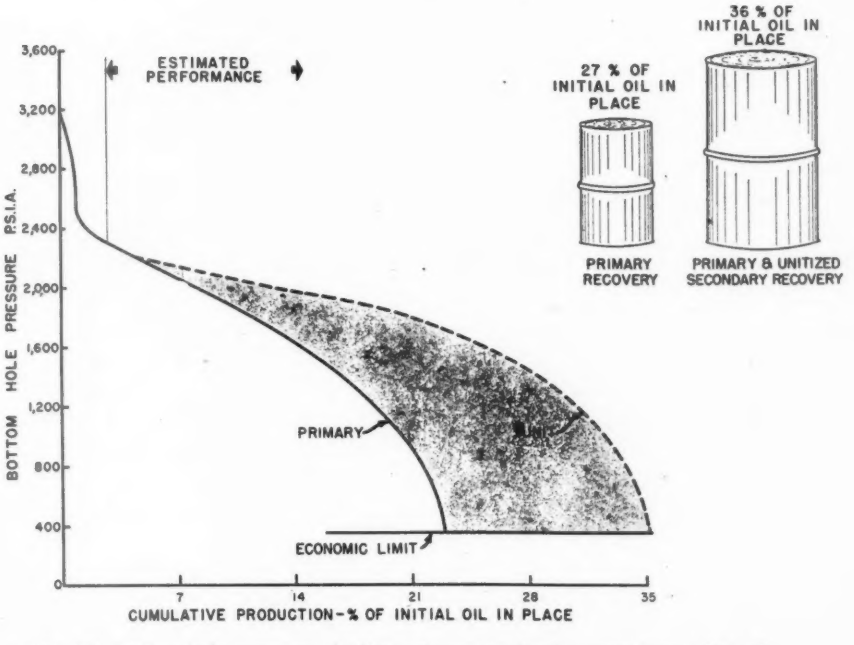
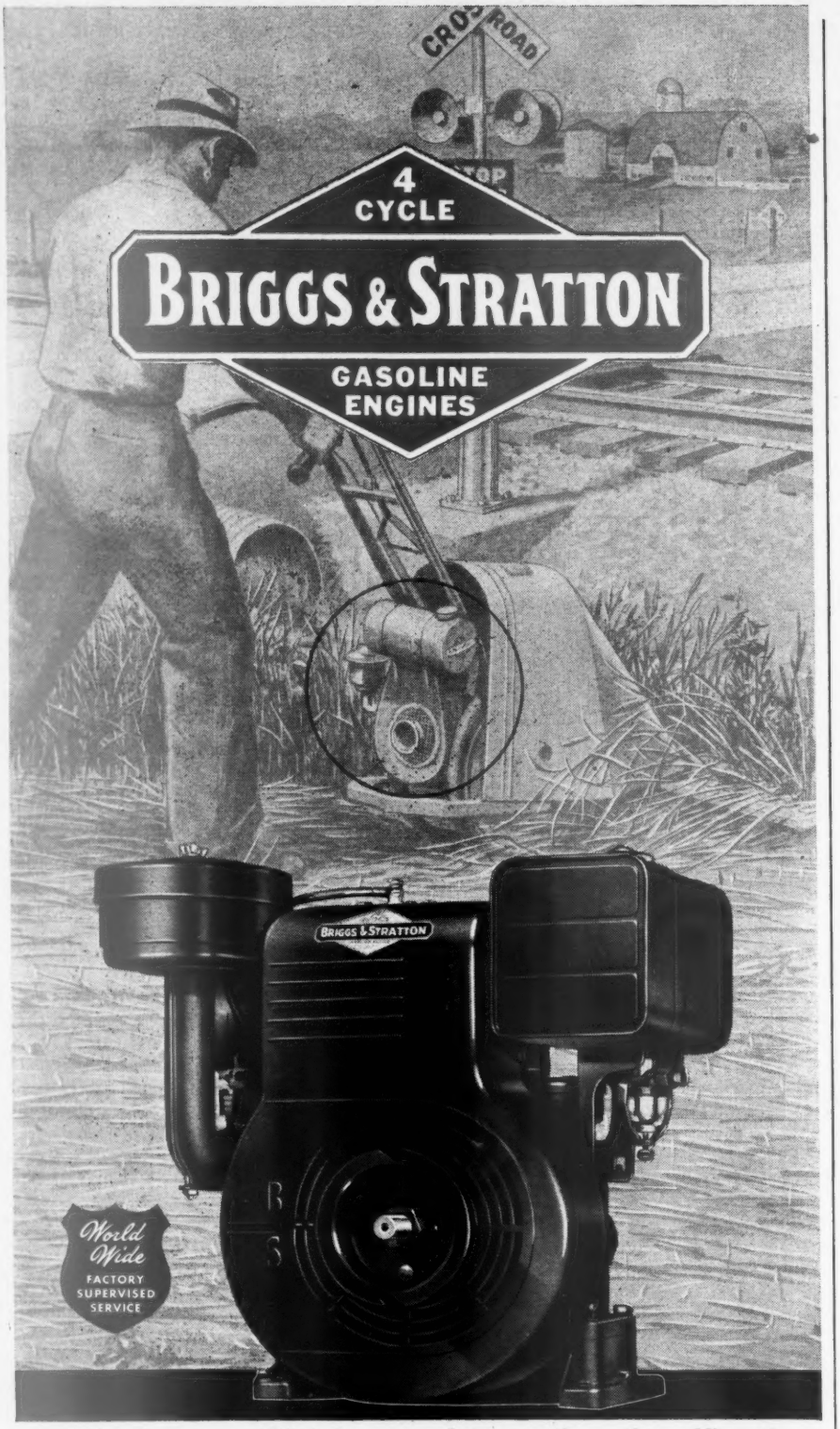


FIG. 12. Bottom hole pressure decline primary and unit operations—Unit C.



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Unit "D"

Only one working interest owner and three royalty owners are involved in Unit "D", which makes it somewhat unusual, though perhaps not unique. Unit "D" is distinguished also by the fact that there are currently both gas injection and water flooding programs being conducted.

A plan of the unit area as shown by Fig. 13 and Fig. 14 is a cross-section of the Oligocene pay sands of the reservoir which shows the position of the sands on the flank of a salt dome.

The gross production and revenue for primary recovery as compared to that for the unitized recovery program now in operation for all three sands are shown in Fig. 15. The economic advantages of these two methods of operation for any particular unit become questions of degree.

There is one operational feature of interest that is being conducted in the upper sand and that probably would not have been attempted if the field had not been unitized. By referring again to Fig. 14 the gas injection well marked X is positioned high on the structure but not at the very crest. The engineering performance prediction is as follows:

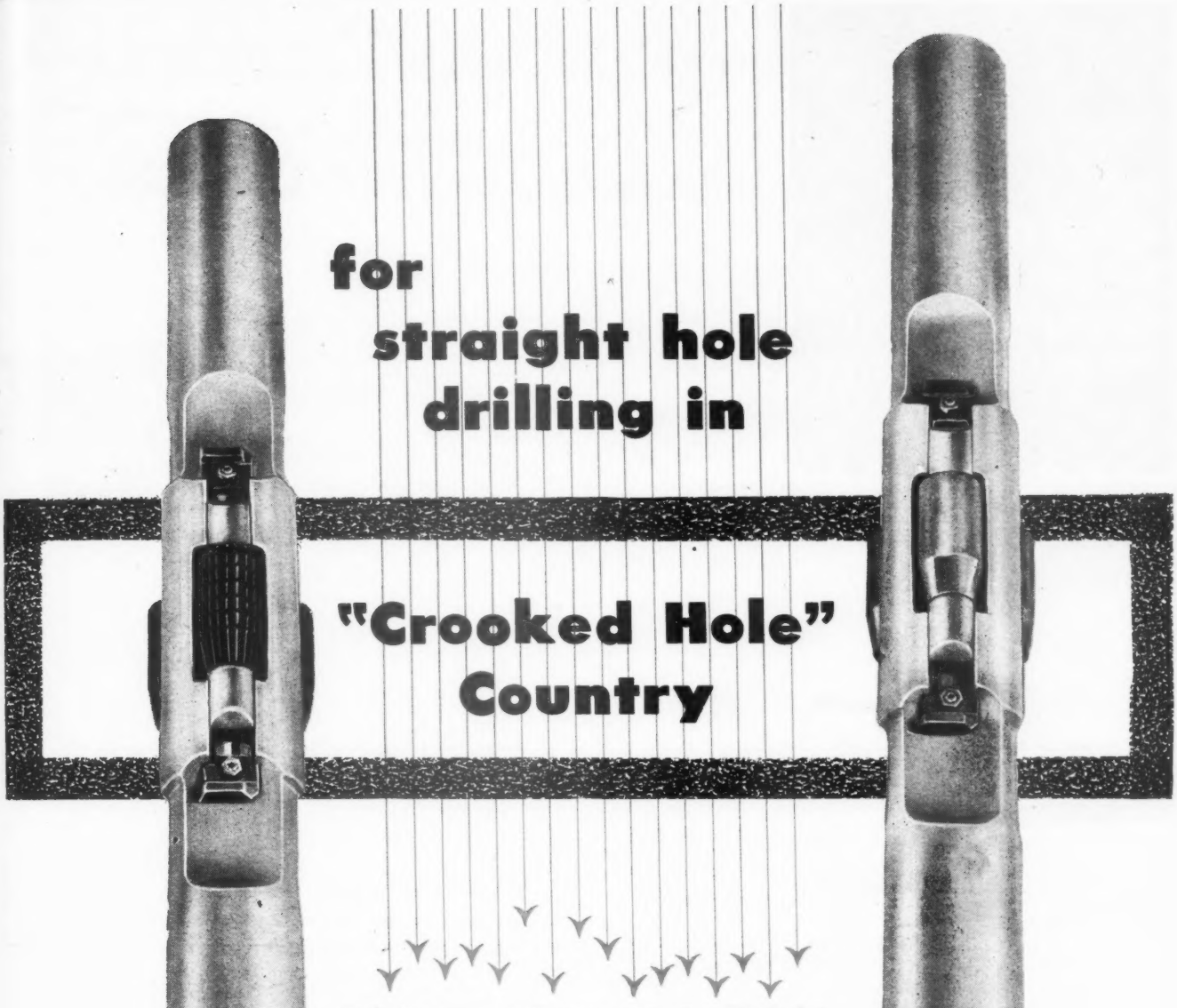
Injected gas will rise by gravity segregation to the up-dip limits of the reservoir marked Y. In so doing, a half million barrels of oil will be displaced downward to be produced from down-dip producing wells marked Z. This oil would be otherwise unrecoverable because it is now confined in the irregular wedge points along the pinch-out Y. The pressure thus exerted by the injected gas, together with a controlled rate of withdrawal from wells Z, will allow the natural water drive, marked Oil-Water Contact, to encroach up dip at a predetermined rate. At the end a maximum recovery of oil will have been effected from all the porosity lower than the highest structural well X, and the porosity above this elevation will be filled with gas only.

This production and fuel conservation procedure is calculated to save $788,000 in initial investment expenses and to produce a half million more barrels of oil than would be possible with any other type secondary recovery program. Somewhat similar depletion programs will doubtless be put into operation in the other two sands.

A question may arise as to why unitization was considered when there was no danger of pushing oil into another operator's wells as one operator owned the exclusive rights to search for and recover the oil. The answer is diversity of royalty ownership. It will not matter from which well or wells the operator derives his revenue in a case like this, but an inequity to royalty owners would have resulted without unitization because oil under some of the individual tracts will possibly be pushed to adjoining tracts to be produced. It was cognizance of this situation that led to the formation of the unit.

The main things for attention in Unit "D" are the following two facts:

for straight hole drilling in "Crooked Hole" Country



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- Minimize "dog legs" caused by drill stem buckle and whip.
- Apply more weight before drill collar buckle point is reached.

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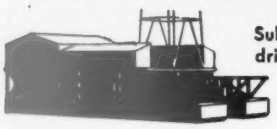
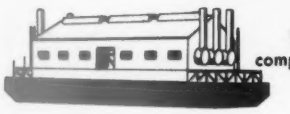


Submersible drill barges

Tugs



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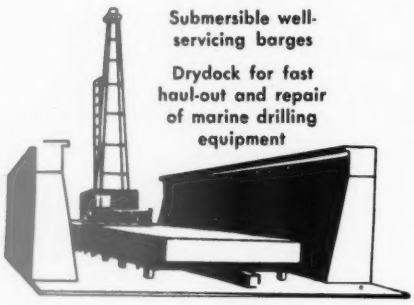

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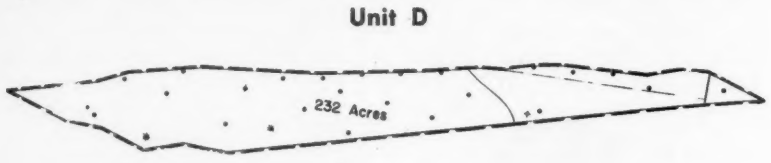


FIG. 13. Operating rights owned by one operator—Unit D.

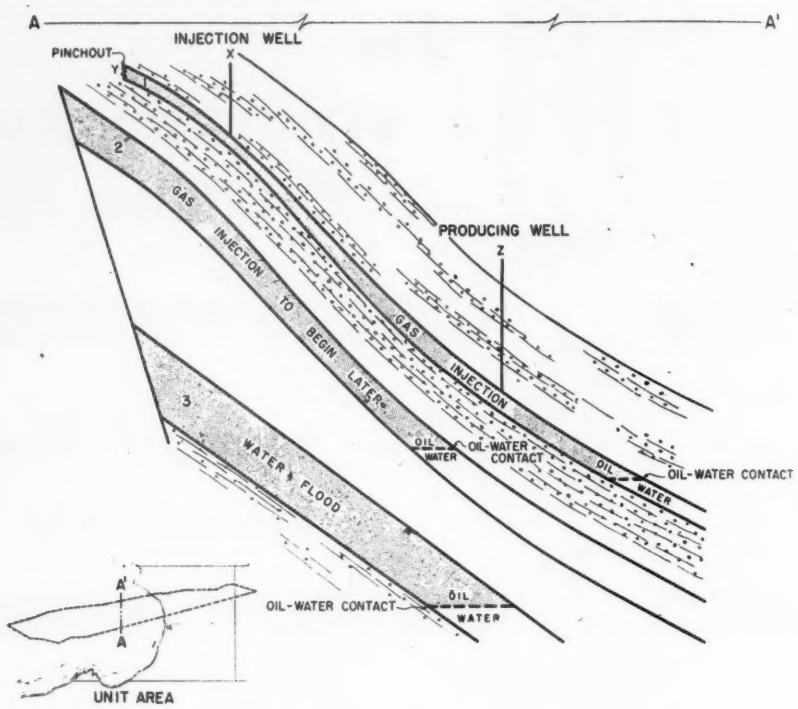


FIG. 14. Cross section—Unit D.

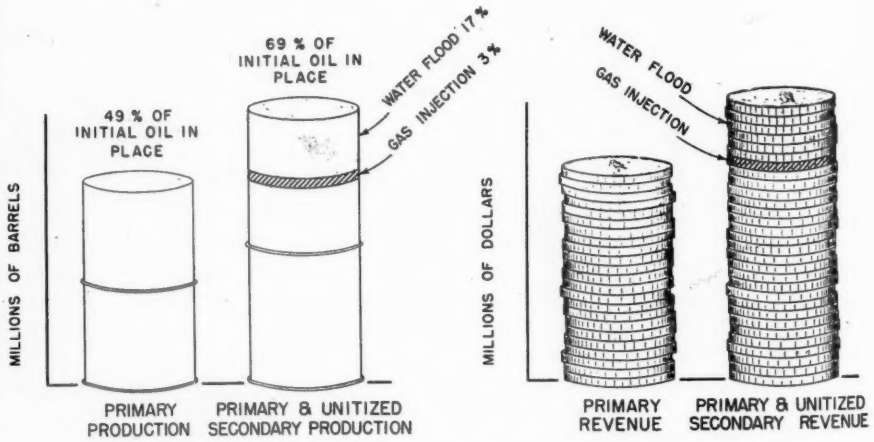


FIG. 15. Production and revenue—primary and unit programs—Unit D.

1. A unit does not necessarily have to involve huge acreage or a variety of operator ownership.
2. Where a single operator controls all production in a given field the contemplation of a secondary program because it will entail fluid movements across property lines, should be viewed in the light of protecting the correlative rights of the royalty owners while effecting the maximum oil recovery by the most efficient depletion method which is applicable.

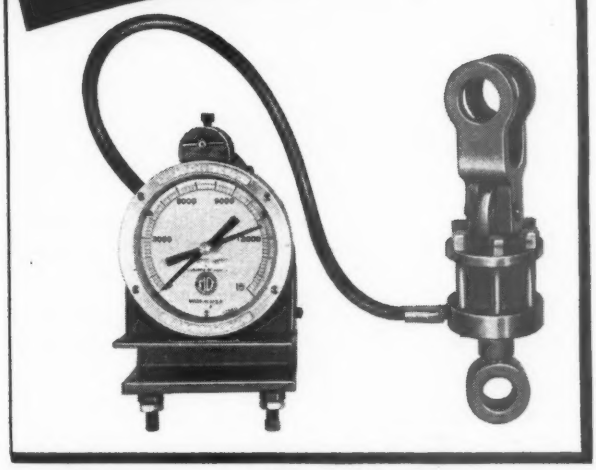
It is becoming more evident every day that unitized secondary recovery programs will occupy a very important part in conserving our nation's oil and gas reserves. The initiative for forming these units must come from within the oil industry, for it alone is best equipped to keep its own house in order. It is un-

Here's What One Major Oil Company Accomplished

Saved $18,450 and Reduced Fishing Time 77%*

(in one year)

Drill Collar Service Increased by Controlling Tong Torque with the MARTIN-DECKER TONG TORQUE GAUGE



The Martin-Decker Tong Torque Gauge removes the two basic causes of drill collar failures—overtonging and loose joints. OVERTONGING results in pulled and distorted threads. RUNNNING COLLARS TOO LOOSE allows the joints to work, resulting in cracks and washouts.

The Martin-Decker Tong Torque Gauge is simple in construction and design, consisting of a hydraulic unit attached to a gauge by means of high-pressure hose. A pre-set hand on the gauge shows where the torque is high enough or how much has been pulled, as desired. The gauge is in direct line of the driller's vision.

*Economy of Controlled Torque

(Obtained by a major oil company)

The operating days and footage drilled with four classifications of drill collars. The first period reflects operating data for a year prior to field application of the tong torque indicator and the second period represents a year following utilization of the indicator. The days and footage drilled by the four classifications of collars are comparable; yet the total time spent in fishing for drill collars has been reduced from 712 hours in the first period to 220 hours in the second. This results in a saving of 492 hours, or approximately $18,450, in rig time, based on a rig expense of $900 per day.

The Martin-Decker Tong Torque Indicator was not solely responsible for this saving; however, this instrument contributed greatly to these results since follow-up on drill collar failures shows that the practice of overtonging and running loose joints has been greatly reduced.

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- One torque gauge adaptable to all tong handles.

Write for descriptive literature

	SIZE											
	7¾"			6"			5¼"			4¾" or Less		
PERIOD	Footage	Days	Fishing	Footage	Days	Fishing	Footage	Days	Fishing	Footage	Days	Fishing
1st	115,720	492	206¾	183,420	1682	505¼	18,343	453	0	5,355	73	0
2nd	100,178	404	51¾	216,114	1647	117¾	36,852	797	39⅓	12,968	222	11

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CORRECTION: In Part 1 a statement read: Units are taxed as entities. This is an error. It should read: Units are not taxed as entities.

questionably the responsibility of the oil industry to voluntarily protect the correlative rights of royalty owners. It can hardly be denied that consideration of royalty owners rights in the first instance will diminish to a considerable degree prospective litigation to adjust those rights. Freedom from legal entanglement is a decided economic advantage.

Petroleum Conservation

Specific instances have been pointed out where unitization has indicated economic advantages to the parties who are to follow such a program. It is the operator's responsibility if he believes wholeheartedly in its benefits to actively campaign for its use whenever applicable. To quote now from *Petroleum Conservation*:[8]

> "Cooperative action and unit operation are needed *now*, not to prevent obvious waste, not to act as a brake on drilling and production, but to protect property rights, to preserve individual enterprise, and to permit the effective implementation of advances in technical knowledge, to the end that positive steps may be taken in each pool to bring about a higher extraction efficiency."

There are, of course, many problems yet unsolved in the field of unit operation, but that is only stating a truism of any endeavor. In these hectic days of the attack on the depletion allowance, the controversy over the tidelands, the threat of Federal regulation of natural gas, and the demands of our defense program, to mention just a few, it behooves one to examine every tool at hand with a more critical eye.

Groups are undertaking more concentrated studies of this whole subject. This is a most heartening condition, for it is only by honestly examining every facet of petroleum operations that all can become convinced whether or not a given procedure can be applied for common benefit.

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2. "The Energy Resources of the United States: A Field for Reconstruction," Bull. 102, Vol. I (1918) 91, Smithsonian Institution, United States National Museum, Gilbert and Pogue.
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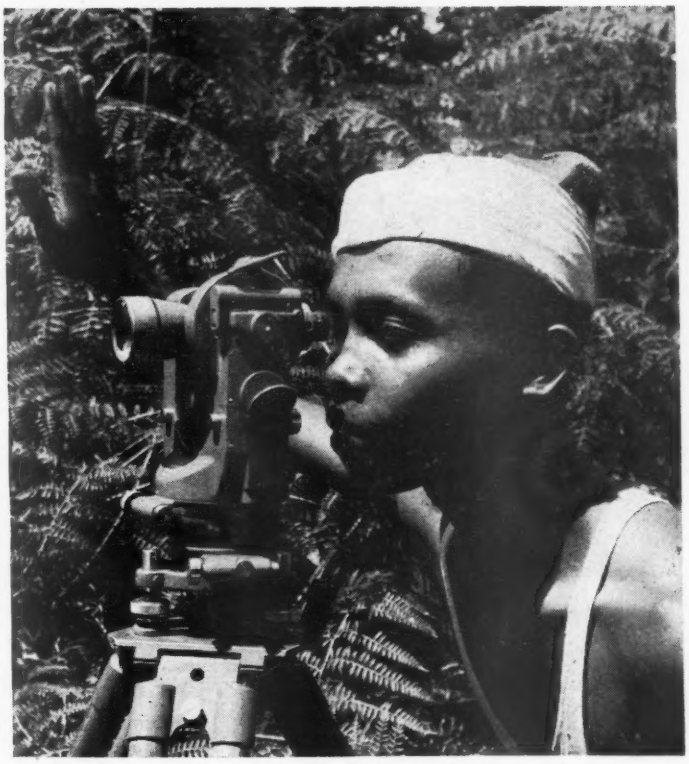
5. "Progress of Unit Operation", Petroleum Division Group Session—Annual Meeting, API (1951), H. H. Kaveler.
6. Engineering and Economic Aspects of Unit Operation", Oil Weekly, (Nov. 21 and Nov. 28, 1930), T. E. Swigart.
7. Ibid.
8. "Petroleum Conservation", Sponsored by Henry L. Doherty Memorial Fund, published by AIME (1951), Edited by Stuart E. Buckley, p. 275.

★ ★ ★

Worker at a christmas tree in Minas field.



Surveyor's helper working in Sumatra.

Caltex Pacific Begins Minas Field Production

Caltex Pacific Petroleum Maatschappij is now placing on production its wells in the Minas field in Central Sumatra, and is ready to make initial overseas shipments. Caltex Pacific Petroleum Maatschappij is one of the Caltex Group of Companies.

Since the company was able to resume full scale operations in Central Sumatra at the beginning of 1950, 33 wells have been completed in the Minas field. For these wells and those to follow, outlet facilities have been provided consisting of a 12-in. pipe line, about 17 miles in length, from the Minas field to an upriver terminal at Perawang on the Siak River, from which the oil will be transported downriver in specially constructed shallow-draft tankers (of about 3400 tons capacity) to the ocean terminal built by the company at Sungai Pakning—a distance of about 90 miles. From the Pakning terminal oil will be available for sale and distribution.

Initial shipments from the Pakning terminal were planned for about May 12 when the tanker *gage lund* was scheduled to "lift" a cargo of about 200,000 bbl. Subsequent shipments will be made at regular intervals.

In bringing its Central Sumatra project to this stage of completion, Caltex Pacific enters a new phase of its Indonesian activities, which began more than 25 years ago. After extensive geological exploration and exploratory drilling in various portions of the archipelago and especially in Sumatra, oil was first discovered in 1939. Work was interrupted

Unloading 50-ton diesel engine driver at Rumbai Terminal of Caltex Pacific.

Corner of drafting room in Rumbai.

by the war and the events that followed, and only during the past two years and a half has it been possible to schedule and carry out the development activities necessary to bring this enterprise to the point that oil can be shipped and sold. The further development program for the Sumatra properties will depend on economic and other circumstances that cannot now be foreseen.

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Montana Office Open

Honolulu Oil Corporation is opening an office in Billings, Montana, from which it will conduct geological and leasing operations for the Williston Basin area.

Paul E. McGovney, formerly of Honolulu's geological office in Bakersfield, California, will be in charge of the Billings office.

Oil Companies Support Study of Subsurface Zone

Five major oil companies will support a $52,000 research project at the University of Texas. The University's Bureau of Economic Geology will make a detailed study of the subsurface Ellenburger formation, a prolific oil source in many West Texas fields, and associated rocks in Texas.

Atlantic Refining Company, Gulf Oil Corporation, Humble Oil and Refining Company, Shell Oil Company, and Texas Company are supporting the project.

Dr. V. E. Barnes, Bureau research scientist, will direct the research which will extend over a three-year period. Bureau publications will report results.

"The Ellenburger probably is a potential producer of many additional fields," Dr. John T. Lonsdale, Bureau director, said. "Discovery of such fields, however, is becoming more difficult and more expensive".

Crowell Buys NGAC Assets

Natural Gas Associated Consultants of New Orleans, Louisiana, has been legally dissolved and the offices at 427 California Building and 1441 Canal Street have been closed. A new building has been constructed by Alec Crowell on the William David Parkway in New Orleans and the assets of NGAC taken over at that address by Crowell Oil and Gas Exploration.

Scurry Group Agrees On Unitization Plan

An agreement has been reached on an unit plan in Scurry County, Texas, according to M. Darwin Kirk, vice president of Sunray Oil Corporation, and chairman of the executive committee of the Scurry Area Canyon Reef Operators Committee. Lessees operating approximately 84 per cent of the proposed unit area for the Canyon Reef pool of the Kelley-Snyder field and Diamond M field in Scurry County have signed the unit operation plan, and, Kirk reported, many additional lessees have committed themselves verbally to the execution of this agreement.

Plan for unitization is the same as that now applied in the Diamond M unit to the south of the Scurry unit.

Clay Technology Meeting Planned for Next Month

The National Conference on Clays and Clay Technology will be held at the University of California, Berkley, on July 21-25, W. H. Somerton, assistant professor of petroleum engineering at the University, has reported. Of special interest to the petroleum industry is the July 25 session, which features clay technology in the petroleum industry.

Delmar H. Larsen, consulting chemical engineer, Los Angeles, will speak on "Drilling Fluids" and S. T. Yuster, department of engineering, University of California, will discuss reservoir problems. Two other discussions will be held in the morning session, namely, M. R. J. Wyllie, Gulf Research and Development, Pittsburgh, Pennsylvania, will speak on well log interpretation, and I. A. Cole, director of research, Attapulgus Clay Company, Philadelphia, will discuss refining and adsorption processes.

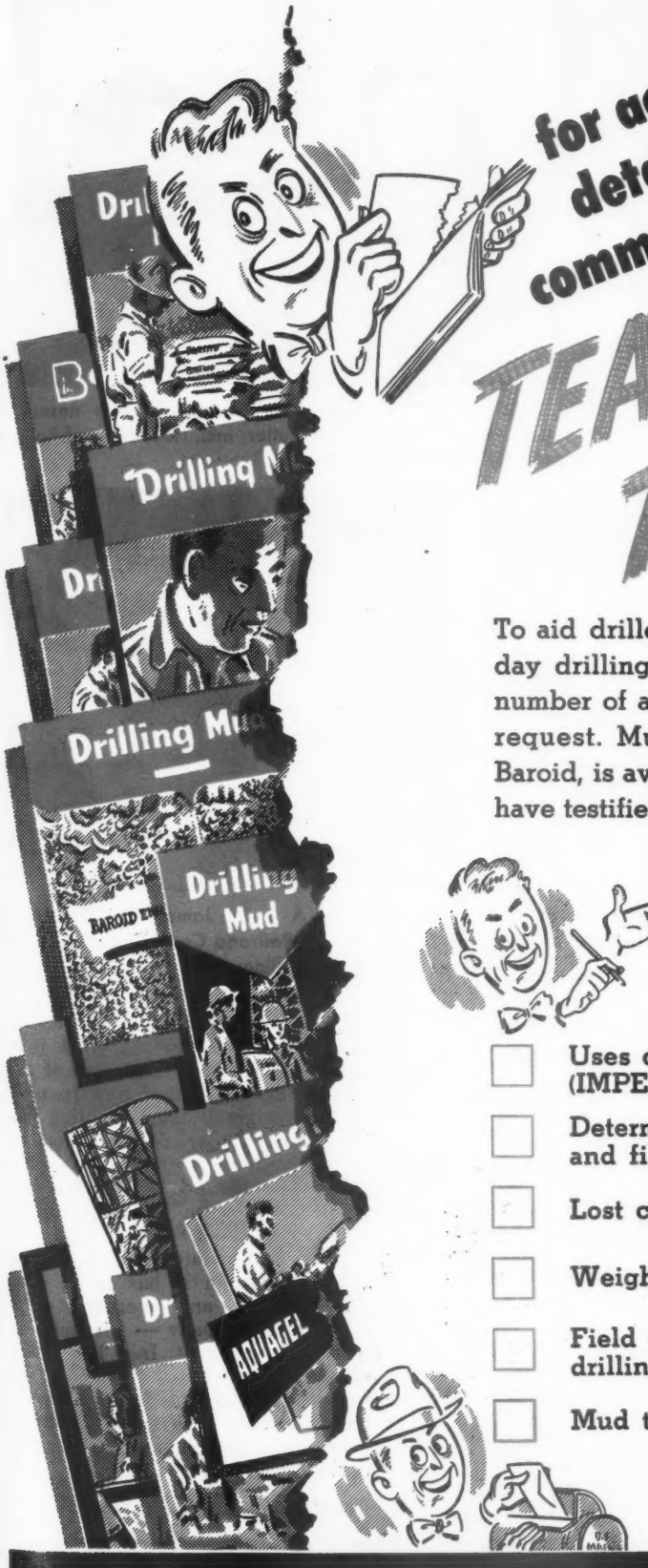
Grant A. Mickelson, Filtrol Corporation, Los Angeles, will be in charge of the afternoon session and will speak on refining and catalysts.

Corporate Name Changed

Warren and Bradshaw Drilling Company, Inc., of Tulsa, Oklahoma, has announced the official change of its corporate name to Warren-Bradshaw Exploration Company. With the announcement, the company also made known its plans to expand both its drilling and exploration departments.

R. B. Warren, Jr., president of the company reported that Oadus White, formerly division drilling superintendent with headquarters in Oklahoma City, has been promoted to drilling superintendent in Tulsa. He also announced two other personnel changes: King H. Reed, formerly production foreman of the West-Texas-New Mexico district, in Odessa, Texas, has been promoted to production superintendent in Tulsa, and LeRoy F. Stewart, geologist, formerly of Fort Worth, and a graduate of Oklahoma University, will head the newly formed exploration department, with offices in Tulsa.

The company was formed in 1936.



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Attending Fourth Annual Oil Recovery Conference banquet in Austin recently are: D. V. Carter, Magnolia Petroleum Company, Dallas, Texas; L. A. Ogden, Pure Oil Company, Tulsa, Oklahoma; P. B. Crawford, Texas Petroleum Research Committee; Kenneth B. Ford, J. R. Butler, Inc., Houston, and Robert B. Parriott, Stickle Drilling Company.

Other Scenes at the Banquet Show Robert L. Whiting, Research Committee; Harvey T. Kennedy, petroleum engineering professor, A & M College; Harold Vance, head, petroleum engineering department, Texas A & M; James P. Hart, chancellor of T. U.; W. J. Murray, Jr., Railroad Commission of Texas; P. B. Crawford, and Douglas M. Collingwood, Sun Oil, Dallas.

Oil Recovery Group Meets

The Texas Petroleum Research Committee, formed under the auspices of the A and M College of Texas, the Railroad Commission of Texas, and the University of Texas, held its fourth oil recovery conference recently in the Hogg Memorial Auditorium, University of Texas, Austin.

Dr. Theophilus S. Painter, president of TU, opened the conference.

Committee-member chairmen presiding over the sessions were, Harry H. Power, Harold Vance, Albert B. Stevens, Paul B. Crawford (assistant director), and Robert L. Whiting, who is acting director of the committee.

W. J. Murray, Jr., Railroad Commission of Texas, was toastmaster at the banquet held in the Stephen F. Austin Hotel, when the chancellor of the University of Texas System, Dr. James P. Hart, spoke on, "Experts and Education."

Among the many oil personalities present at Austin were: H. D. Aggers, Union Oil Company of California; H. J. Brady, Seaboard; J. C. Calhoun, Pennsylvania State College; J. L. P. Campbell, Lane Wells; D. V. Carter, Magnolia; E. F. Kelly, Dowell; W. F. Howard, Halliburton, and D. A. Shock, Continental Oil.

General Petroleum to Buy San Ardo Field Properties

General Petroleum Corporation is negotiating for the purchase of properties in the San Ardo oil field, in Monterey County, California, presently operated by the Jergins Oil Company and the General American Oil Company. Agreement has been reached with General American for its half of the property, and General Petroleum is contracting with Monterey Oil Company and Wilmington Associates, Inc., for the purchase of the other half if, as, and when these two companies receive the San Ardo interests from the Jergins Oil Company, which is currently in liquidation. The purchase deal, if completed, will involve the payment of cash and the assumption of payments to be made out of oil produced from the property. The aggregate of these payments is about $36,000,000.

San Juan Oil Formed

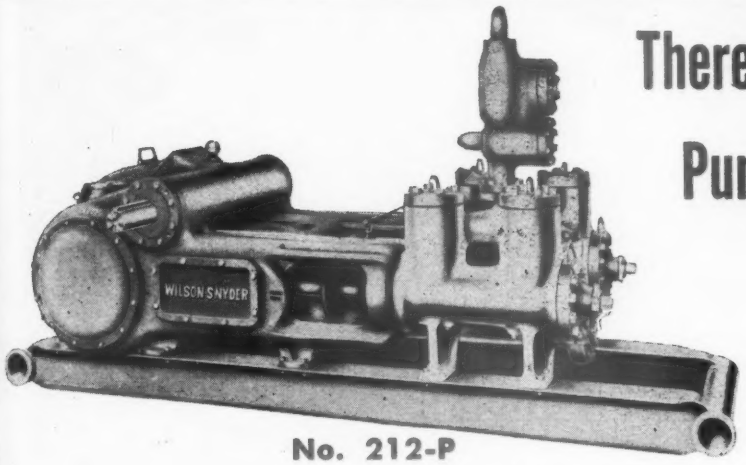
San Juanito Oil Company, according to a statement made by its president, Robert J. Bradley, has officially changed its name to "San Juan Oil Company."

San Juanito was an outgrowth of the original San Juan Oil Company, which was recently dissolved as a consequence of an exchange of stock with General American Oil Company. At that time the officers and "key" employees of the original company formed San Juanito. All of the original staff, including five engineers and geologists, were retained with the continuing organization. San Juan is now identified as the operator and manager of the Mazda Oil Corporation, formerly of Tulsa, Oklahoma, and Texas Consolidated Oils of Dallas, Texas. In addition it has taken over the management and operation of a newly formed company — Oil and Gas Property Management, Inc. The latter company, formed by a New York investment group, recently filed a registration statement with the SEC for a ten million dollar capitalization, for acquiring producing properties.

April Crude Output Up Saudi Arabia Reports

Crude oil production in Saudi Arabia during April amounted to 26,362,689 bbl, or an average of 878,756 bbl per calendar day, it was announced by the Arabian American Oil Company.

Production in March totaled 25,463,303 bbl, an average of 821,397 bbl per day. Crude oil production for the first 4 months of 1952 amounted to 103,371,505 bbl, or 854,309 bbl per day.



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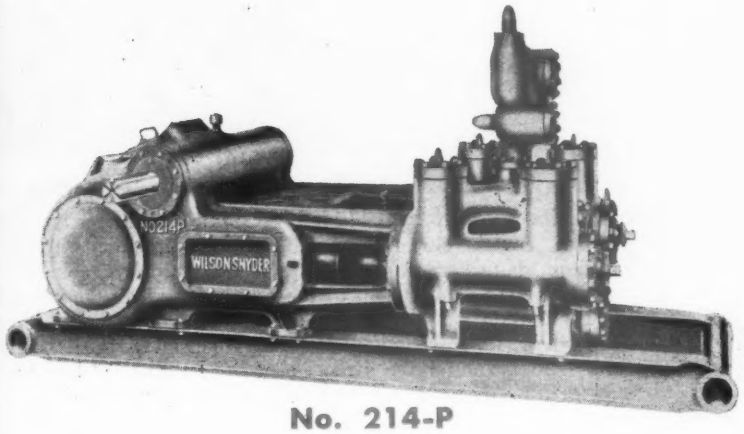


No. 214-P

Shown here are four important sizes in the Wilson-Snyder line of Power Pumps.

Here are a few of their many features:
One-piece, high-strength power frame.

One-piece, direct-flow type, cast steel fluid end with large passages for easy flow.

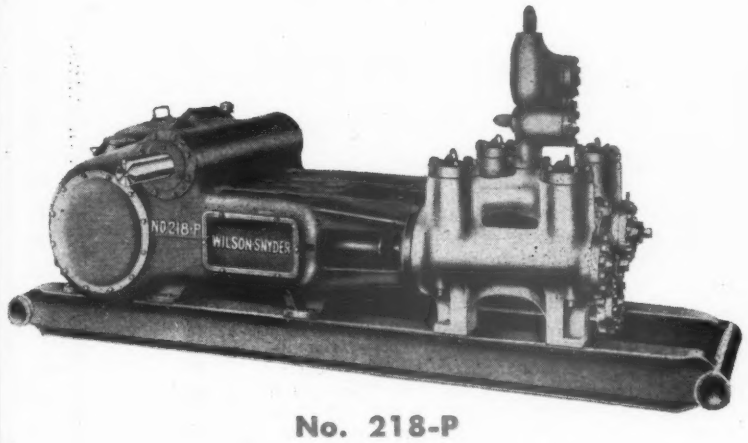
Heavy-duty, field-adjustable roller bearings throughout.

DI-HARD, long-life, fluid-cylinder liners and HI-HARD piston rods.

Forged alloy-steel, heat-treated, fluid valves and seats.

Power end lubricated with combination oil-bath and positive-flow lubrication.

Cross-head pin roller bearings, diaphragm stuffing boxes, and fluid-end stuffing boxes are pressure grease-lubricated.



No. 218-P

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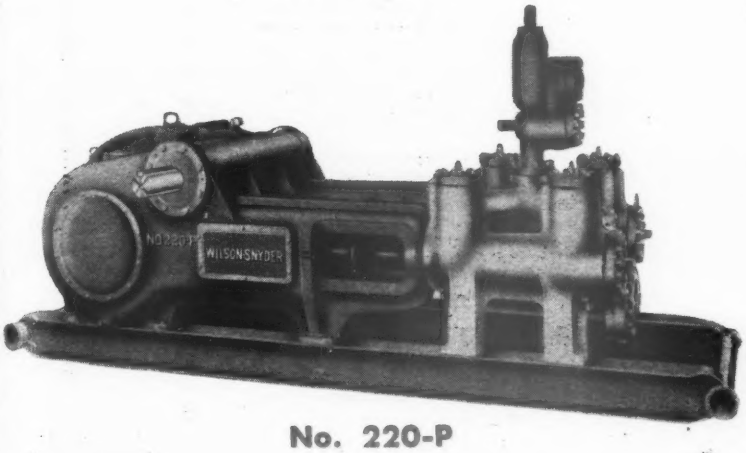

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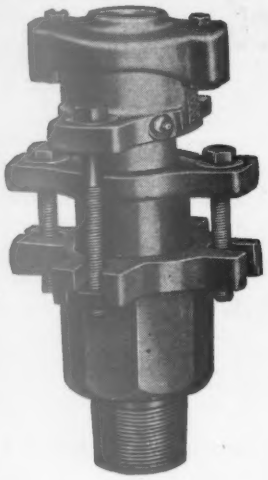
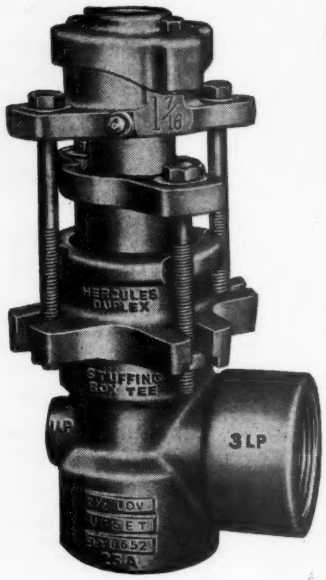
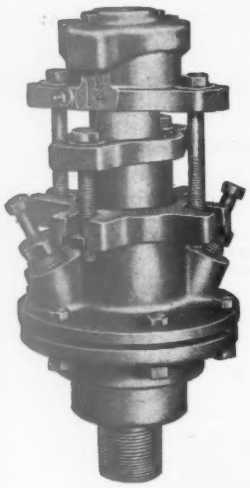


All Hercules Duplex Polished Rod Stuffing Boxes are Cone Packed for longest possible life and greatest economy. Illustrated (left) is Regular Type. Write for Bulletin 120-SB.

The Tee-Base Type Combination Stuffing Box and Tee (directly below) have been proven by years of service and savings to producers. Write for Bulletin 121-SBT.



A double packed Stuffing Box for use under most adverse pumping and flowing conditions (below). Be sure to order Type A-123-SBDP.



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Graham Family on Tour of South America

Douglas H. Graham, president of Dunlap and Graham, Inc., drilling contractors of Long Beach, accompanied by Mrs. Graham, daughter Mardel, and son Douglas, Jr., took off recently on an extended tour of the South American countries in a PBY plane. The itinerary includes Panama, Colombia, Peru, Chile, Argentina, Uruguay, Bolivia, Venezuela, Haiti. Dunlap and Graham, under the direction of W. J. "Swede" Larsen, is now drilling its fifth well for Empresa Petrolera Fiscal.

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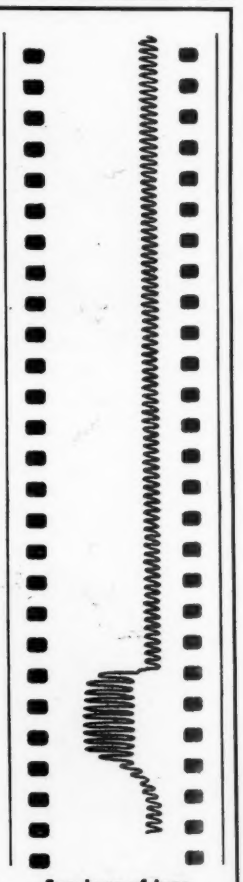

Specimen of tape indicating saturation

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Automatic shut-off with absolute reliability safeguards equipment, prevents waste.

SPECIFICATIONS:

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- Maximum overpressure setting — 5000 psi.
- Maximum underpressure setting — 4000 psi.
- Overpressure, underpressure, or pilot-operated combination units.
- Angle or in-line design.
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If well flow lines should fracture or freeze . . . if other equipment should fail—will you be ready? For any well head emergency, Grove Model 390 Protection Systems automatically stop the flow—dead tight! They operate as often as required—many times a day, or once in a lifetime. Overpressure or underpressure settings are easily made or changed in the field. Resetting can be manual or automatic.

Model 390 main and pilot valves utilize the patented Grove Dome-loaded Diaphragm-operated principle. Pressure range is universal. Loading is quick and accurate. Elimination of springs, pistons and stuffing boxes assures a tight seal with no chance of corrosion or sticking.

Grove automatic Well Head Protection Systems offer the safest, surest emergency shut-off control available. Wire or write today for detailed technical information.

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What's Doing in Drilling

Shell Oil Completes Big Williston Basin Producer

Shell Oil Company has what is being termed the "biggest producer in the Williston Basin". It is the company's No. 34-26-G which flowed 3500 bbl of oil per day through a ¾-in. choke from perforations between 8968-9007 ft after acidizing. Tubing pressure was reported at 350 psi. Shell's Rocky Mountain division manager, J. E. Clark, reported the well had an estimated flowing potential of 6700 bbl, but equipment at the well was not capable of handling such a large volume.

Oklahoma Pool Extended

The northeast Edmond pool of Oklahoma County, Oklahoma, has been extended ¾-mile to the south with a new producing zone opened in the field by Sterling Oil of Oklahoma, Inc. The company's No. 1 Stephens, which was drilled in to 6001 ft, swabbed, and kicked off, and flowed to pits for 2 hr while cleaning out. Five and one-half inch casing was set on top of the Bartlesville zone at 5989 ft.

Pacific Petroleum Extends Peace River Gas Area

Pacific Petroleums, Ltd., is doing extensive drilling in the Peace River area of Alberta, Canada. Recently reported is the Wilrich Bonanza No. 2 well drilling in the Pouce Coupe field, six miles east of the British Columbia border, and lying almost directly on the route of the West Coast Transmission Company's natural gas pipe line. The well is producing from the Cadomin formation, some 2000 ft below the Viking sand equivalent, productive horizon in the field. This indicates a new producing zone for the field. In 2 successive drillstem tests, of an interval of 12 ft, gas was received at the rate of 3,150,000 cu ft.

Another well drilled by Pacific Petroleums is the Pacific Fort St. John No. 4 well, in the Fort St. John area of British Columbia. This well, which has 4 separate gas productive formations, flowed 6,131,000 cu ft per day from the Permo-Pennsylvanian formation. This is the first well to have reached the Permo-Pennsylvanian zone since it was reached in the discovery well last November.

In the Peace River area of northeastern British Columbia, the company's Pacific Fort St. John No. 7 has proved successful on tests. Two drillstem tests were run in the upper Triassic formation, which flowed gas at the rate of 1,394,000 cu ft per day. These two tests have opened up 44 ft of water-free pay zone to date in this formation. The Fort St. John No. 8 has been staked and drilling is expected to begin soon.

Gulf Well Flows 631 Bbl of Oil in 24 Hr

Gulf Oil Corporation's No. 2 Mainka-Ring Unit in Grady County, Oklahoma, has been drilled to a totaled depth of 13,445 ft in the McLish sand. On production tests through perforations in the Second Bromide sand between 12,835-13,049 ft the well flowed 631 bbl of 46.2 gravity oil in 24 hr through a ¼-in. choke. Gas flow was at a rate of 2,800,000 cu ft in 24 hr.

Kansas Pool Gets Well

Cities Service Oil Company (Delaware) is giving the Ironclad pool of Graham County, Kansas, a ¼-mile southeastern extension in the completion of its Holzhauer B No. 2 for an initial of 778 bbl of oil daily. Biggest producer for the area to date, the well is producing from four areas in the Lansing-Kansas City limestone, topped at 3591 ft.

Magnolia Adds Well To Milroy Oil Field

Magnolia Petroleum Company has drilled a new well in the Milroy pool of Stephens County, Oklahoma, getting 20 bbl of oil hourly on test at the company's No. 16 Martin. On a 45-min test at 1620-45 ft, the well flowed oil in 35 min at 20 bbl per hour and recovered 240 ft of oil.

Rudman Completes Well In North Dakota County

The M. B. Rudman, et al, Math Iverson No. 1, Williams County, North Dakota, has been reported making 30 bbl an hour on 2-hr test with a ¼-in. choke. Flowing pressure on the tubing was 1350 lb and 1450 on the casing with an oil gravity of 43.2 to 45 degrees, and 145 ft of effective Madison pay though only 20 ft was perforated from 8470 to 8490 ft, Herman Lewis, production superintendent stated.

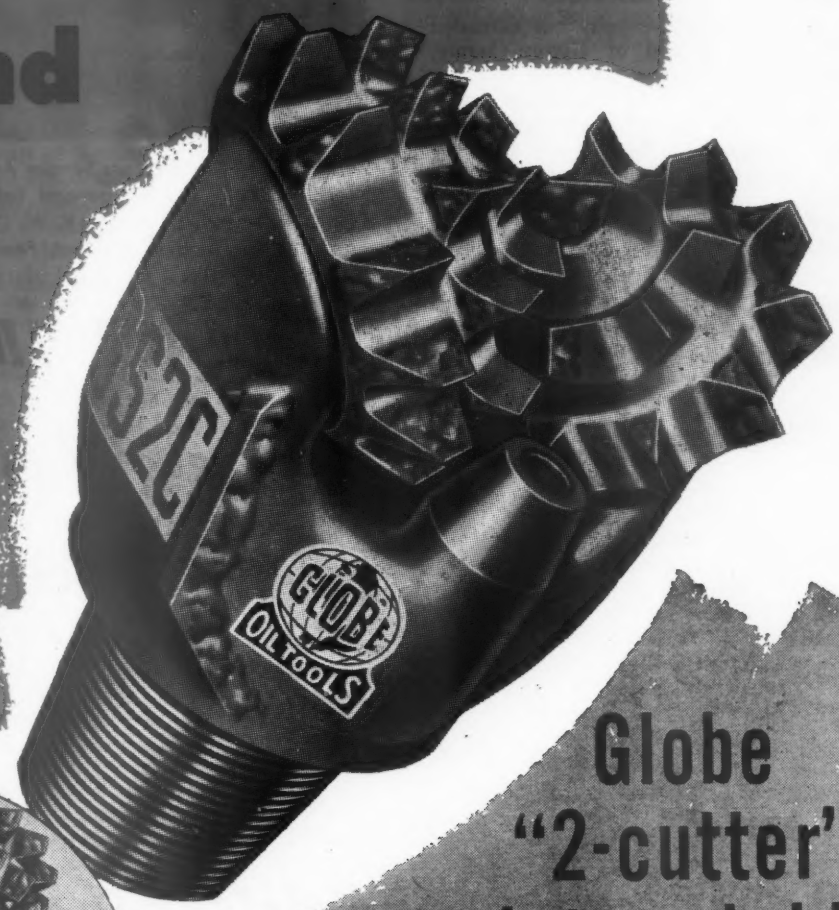
Rudman, who sold 10,000 acres to the Amerada Petroleum Corporation retaining a 3 per cent interest prior to that company's discovery well, is the first independent producer to complete a producing well in the state. Rudman has retained 31,000 acres checkerboarded on this structure and on the Nesson anticline. The Math Iverson has had two other pays of 60 and 25 bbl an hour at lower depths, below 11,000 ft.

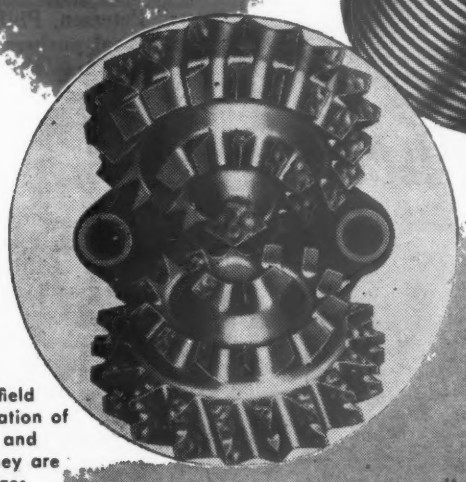
Kansas Wildcat Reworked For 25 Bbl an Hour

D. R. Lauck Oil Company is working an abandoned well in Gove County, Kansas, and is swabbing 25 bbl of oil hourly from it. Abandoned in 1940 the well is a rank wildcat, situated some 12 miles southwest of the recently discovered Lundgren field. The well, the No. 1 Jones, is believed to have an ultimate potential of 1000-2000 bbl.

Delta Company's drilling crew on J. M. Spinks No. 1, Gregg County, Texas, are: D. E. Jumper, D. R. Rhodes, Noah Hart (driller), E. M. McBride (toolpusher), J. D. Williams (Wm. Cameron service engineer), J. J. Johnson and J. O. Hasley.

The dollar and cents end of your drill string





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Skelly Well Brought In

Skelly Oil Company has completed a new well in Stephens County, Oklahoma, at its No. 2 Johnson. The well, plugged back to 4231 ft, flowed 367 bbl of oil in 14 hr.

Wilshire Extends Field

Wilshire Oil Company has extended the Wilshire field of Upton County, Texas, with its most northerly test, the No. 23-130 McElroy Ranch Company. The well flowed 315 bbl of 54-gravity oil in two hours, on a 2-hr, 36-min drillstem test between 12,055-225 ft in the Ellenburger. The 2000-ft water blanket began flowing out in 21 min, mud in 30 min, and oil in 36 min.

Receiving Loffland Brothers Service Awards were B. B. Smith, executive vice president; A. H. "Cotton" Holder, general field superintendent, Pacific Coast Division; P. C. "Pete" Petersen, tool pusher; R. W. "Bob" Wire, president; Phil Burbank, tool pusher; and John Grant, vice president, Pacific Coast Division.

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O-C-T Needle Valve bodies are single piece drop forged steel. The male thread is made as an integral part of the valve which gives you a more compact, stronger connection. This one-piece O-C-T Needle Valve design eliminates the use of nipples and minimizes the chances for leakage. Buy O-C-T Needle Valves from your supply store. There is a difference . . . and O-C-T makes the difference!

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Loffland Men Awarded For Long-Time Service

Employees and officials of Loffland Brothers Drilling Company recently gathered at the Circle J. Ranch in Newhall, California, to witness the presentation of 25-year service awards to a number of staff members. Although service awards are a common thing in the oil industry, they are rare in drilling.

The awards, which were made by R. W. "Bob" Wire, president of Loffland Brothers, aided by B. B. Smith, executive vice president, and John Grant, vice president of the Pacific Coast division of the company, were suitably inscribed gold watches. Recipients were A. H. "Cotton" Holder, general field superintendent of the Pacific Coast division; P. C. "Pete" Petersen, Phil Burbank, and Jim Jones, tool pushers. The last was unable to be present for the official award, but was recognized in absentia.

President Wire commended the four men warmly on the length of their service and caliber of their efforts, and expressed the hope that this was merely the beginning of a long sustained program of recognition. He remarked that while the contract drilling business was in the beginning a loose, somewhat uncertain enterprise, over the years it has acquired a cohesion and stability, of which these 25-year awards are convincing evidence. Following the California ceremony, the Tulsa executives took off for the Mid-Continent where they were scheduled to make seven more awards.

Humble Completes Third Alabama Oil Producer

Humble Oil and Refining Company has brought in its third producer in the Pollard field of Escambia County, Alabama. The well, A. W. Moye No. 2, has been given a calculated daily flow of 141 bbl of 30 gravity oil.

Midstates' Well Flowing

Midstates Oil Company's No. 1 Drummond is showing production in the Chitwood pool of Grady County, Oklahoma. Perforating at 11,479-415, the well flowed 201 bbl of 44.2-gravity oil in 22 hr through a 1/8-in. choke. Total depth was 11,888 ft.

Rotary Rigs Operating in Oil Fields of United States and Canada*

Weeks	Total	Gulf Coast	Pacific Coast	Illinois Oklahoma Kansas	Rocky Mountain Canada	West Texas New Mexico	Arkansas Louisiana Texas	North Texas
(April)								
Third	2908	609	160	606	345	747	145	318
Fourth	2854	597	160	576	328	722	148	323
(May)								
First	2986	610	159	658	359	726	142	348
Second	3028	616	159	674	385	704	181	348

*As reported to the American Association of Oilwell Drilling Contractors by Hughes Tool Company.

Zephyr Oil Well Proves Good Oklahoma Producer

Zephyr Petroleum Company has a prolific well in Logan County, Oklahoma. It is the No. 2 Giddings, which flowed 243 bbl of oil in 3 hr through a 1-in. choke from the Second Wilcox sand between 5141-51 ft. During the last hour it made 95 bbl of oil. It flowed 46 bbl of oil in 1 hr when pinched to a ½-in. choke and was flowing at a rate of 26 bbl an hour through a 24/64-in. choke.

Oil Development in England

The geophysical section of the Anglo-Iranian Oil Company's research station at Kirklington Hall, England, is now in the midst of one of its busiest periods the company has reported. New equipment is being tested in the grounds of the Hall for a seismic survey of an area east of Nottingham—the first to be carried out in this country since that at Formby, Lancashire, two years ago.

The results of former surveys, which covered important areas of the East Midlands has been studied. Geological examinations are now being made of the various prospects that have come to light, in order to assess their value as possible sites for test drilling. Previous search produced evidence of oil in small quantities over a wide area outside the developed fields and it is hoped that a new drilling program will emerge to follow up some of these indications.

At Formby, deep test drilling continues in the search for a major oil accumulation. Three additional shallow holes drilled between the existing producing wells have added appreciably to the yield of the existing field and show that there is scope for development.

New Amerada Well Is North Dakota's Ninth

Amerada Petroleum Corporation has completed its Almer Iverson No. 1 in the Beaver Lodge Madison pool, North Dakota's ninth oil well. After gaging 407 bbl of oil, the well is producing from 8572-8596 ft. It gaged 407 bbl of oil and 576,000 cu ft of gas in a 19-hr test through a ¼-in. choke.

Arbuckle Lime Well Flowing

The old Cushing oil field in Creek County, Oklahoma, has been given a new well flowing from the Arbuckle Lime, said to be the best well from this zone found in Oklahoma in several years. It is Deep Rock Oil Company's No. 1 Wacobe, in which crude saturation was found 13 ft in the Arbuckle from 2940 to 2953 ft. A 25-bbl an hour producer has been forecast.

Mungerville Well Success

A good producer for the one-well Mungerville pool of Dawson County, Texas, is indicated in a test of the Cities Service Oil Company-H. L. Hunt Brennand No. 1. The well flowed at the rate of 840 bbl of oil in 24 hours from the Wolfcamp reef, topped at 8597 ft. The Brennand well is a northeast offset to the El Tee No. 1 Briley discovery and seven miles south of the Welsh pool.

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Costly pump repairs - - - ?
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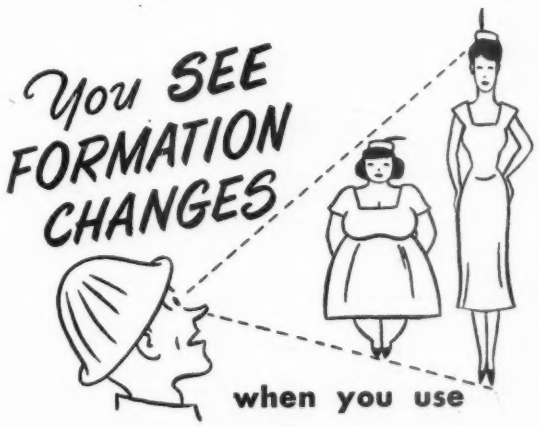

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Exploration Activities

Widespread Interest Seen In Anadarko Ridge Test

J. Tom Grimmett of Pauls Valley, Oklahoma, has staked a new wildcat in the extreme northeastern part of Beaver County, Oklahoma, on the ridge of the Anadarko Basin. Near this proposed test is the wildcat test, No. 1 Mrs. Cleo Smyers in extreme southwestern Clark, Kansas, drilled by H. M. Acre, Inc. Staking of the wildcats has caused widespread interest in the areas of Beaver and northwestern Harper counties of Northwest Oklahoma and in southeastern Meade and southwest Clark in Kansas.

Samedan Oil Well Shows Oil Signs in Red Fork

Samedan Oil has signs of a commercial production in a wildcat in Lincoln County, Oklahoma. The test is the No. 1 Cunningham. On the first test the Red Fork was topped at 4212 ft and tested at 4211-23 ft with 1-hr try making gas in 10 min at 1,500,000 ft daily, and recovered 20 ft of distillate-cut mud. Second test in the Red Fork was 1-hr opening at 4223-66 ft with 100 ft of heavily oil and gas cut mud showing some free oil. Third opening was 1-hr test at 4238-80 ft with recovery netting 100 ft of oil-cut mud.

New Formation Discovery May Open New Wyoming Area

A new Phosphoria formation discovery has been made in Shakie County, Central Wyoming. It is Gulf Oil Corporation's No. 1 Stockham-Federal, which was originally plugged back to 13,000 ft and cemented for the testing now underway. The Phosphoria was tested and gas was revealed at once, opening up to flow 384 bbl of rich distillate in a 24-hr period, through 2/64-in. tubing choke. Distillate was accompanied by 4,760,000 cu ft of gas. Oil men in the area have termed the strike one of the most important for the area this year, and assert that it will result in further exploration of the deep formations.

New Kansas Discovery Made

Cities Service Oil Company has a Lansing-Kansas City oil discovery on its North Macksville block in Pawnee County, Kansas. The company's Becker B No. 2 flowed 257 bbl of oil in 6½ hr through 5/16-in. choke from perforations in the Lansing-Kansas City limestone from 3743 to 3769 ft and from 3777 to 3783 ft. Top of the Lansing-Kansas City is 3547 ft.

A flow of 160 bbl of oil in four hours was reported later from perforations from 3709 to 3729 ft. The discovery is approximately four miles north of Macksville, Kansas.

General American Has New San Juan Basin Well

Completion of a discovery gas distillate well in Rio Arriba County, New Mexico, in the San Juan Basin, has been announced by General American Oil Company of Texas. The well is the company's No. 1 Harrington, which has been brought in from the Dakota sand, encountered at about 7800 ft. Nearest production is about 10 miles away. The well is reported to have flowed at a rate of 2,600,00 cu ft of gas a day.

Kansas Test Has Oil Show

Hugoton Production Company has indications of a new oil pool in its rank wildcat in Lane County, Kansas, so far an unproductive county. The well is the company's No. 1 Flo. At least two drillstem tests have given indications of oil. One test, taken at 4157-87 ft and open 12 min, yielded 400 ft of heavily oil and gas-cut mud. The other test got 180 ft of oil and 615 ft of oil-cut mud at 4401-24 ft, with tool open 60 min. Hole is being deepened for another test.

Texas Panhandle Gets New Pool at Gulf Well

A new producing oil well has been reported in Roberts County, Texas by Gulf Oil Corporation, who stated that the well opens a new shallow pool for the Texas Panhandle. The well is the No. 2 John Haggard, and Gulf reported that under cable tool test it flowed 78 bbl of oil in 6 hr after hitting gas at 3998 and again at 4005 ft. The oil was found in Brown dolomite at 4009 ft and pressure increased to the 4015-ft point, where the well was shut in.

Mississippi Discovery Made

Southeastern Drilling has a new field in Wayne County, Mississippi. Pool opener is the Gulf Refining No. A-1 Chapman, which flowed at the rate of 494 bbl of oil a day.

Dow Makes Big Gas Strike In Mason County, Michigan

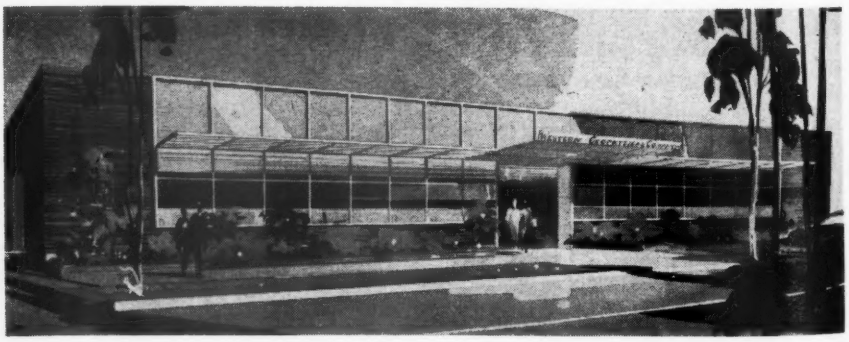
What is considered to be one of the most important gas discoveries ever made in Michigan has been reported by Dow Chemical Company. It is the company's No. 32 Fee in Mason County. On a drillstem test of the Niagaran formation, gas showed immediately and flowed an estimated 9,000,000 cu ft a day. It is believed the well is good for between 12,000,000 and 15,000,000 cu ft of gas daily. Test was made between 4015-115 ft. The Niagaran formation is more than 100 miles farther north than this zone had been found in Michigan, Dow Chemical reports.

Union Oil Completes New California Oil Discovery

Marking the second successful completion within a few weeks on its extensive fee property northwest of McKittrick, California, Union Oil Company has brought in another flowing well producing at the rate of 1920 bbl a day of 37 gravity crude. The well was completed at 6200 ft in the Oceanic Sand. This well, Jewett Fee 83X-24, is an offset to Union's C. C. M. O. 84-24, which the company completed on the Belgian Anticline in March for an initial daily production of 925 bbl of 37 gravity.

Louisiana Gets New Gas Distillate Field

Cities Service Oil Company (Delaware) and Forest Oil Corporation announce discovery of an important gas-distillate pool at Delta No. 1, in Terrebonne Parish, Louisiana. The discovery well has a calculated open flow of 70,000,000 cu ft of gas through perforations in a Miocene standstone at 12,675 to 12,685 ft. Approximately 15 bbl of 45 gravity condensate is produced with each million cubic feet of gas. Total depth is 12,974 ft. Several additional significant gas horizons remain untested.



Artist's Drawing of Western Geophysical Company of America's new headquarters in Los Angeles, California. The new building, which is scheduled for completion in September, will house administrative and operational facilities for the company and its affiliate, Western Geophysical International. Henry Salvatori is president of Western Geophysical.

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Today, the presence of a Core Lab Freeze Box at the well is virtually taken for granted . . . only five short years since this Core Lab-developed technique was introduced to the industry. Simple and efficient . . . Core Lab's Frozen Core Service brings *Off-Location Analysis with On-Location Results* within economic range of every drilling site. For complete details and charges, call the Core Lab man nearest you.

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To obtain more information on products advertised see page E-51

Utah Well Completed

Utah's first discovery this year, the No. 1 Lambert, has been completed by Deep Well Productions, Inc. and Mid-Continent Petroleum. The well is in Duchesene County. The well is pumping from 51 to 72 bbl of oil a day at 6022-26 and 6146-52 and 6200-10 ft in the basal Green River zone.

Nebraska Wildcat Success

Vaughey and Vaughey has completed a wildcat discovery in Kimball County, Nebraska. The new well, the No. 1 Goodwin, pumped 262 bbl of 38 gravity oil through choke in a 24-hr test. Production is coming from the interval 6040-47 ft in the "J" sand.

New California Well Pumps 850 Bbl a Day

A major oil discovery in the Santa Clara Valley, California, 40 miles northwest of Los Angeles, was confirmed by Union Oil Company of California. The discovery well, Torrey 83, is currently pumping 18.5 gravity crude at the rate of 800 bbl a day.

Originally planned to be drilled a maximum 7500 ft to test the Eocene, this well was taken deeper when it encountered more Sespe oil sand than had been anticipated. At 9327 ft the bit was still in the Sespe. Because of the rig's limited capacity, Union stopped drilling at that point to test the 1600 ft of Sespe sand already disclosed by core and log.

Following a short swabbing period, it became evident that there was insufficient gas volume to cause the well to flow at capacity rate and operations were begun to place the well on the pump. While this work was in progress crude oil started flowing through the casing at a rate of 30 bbl an hour. The equipment, however, was installed and the well is currently pumping and agitating 800 bbl a day.

The new field is so promising, the company reports, it has already begun preparing a location for Torrey 84, an offset, 660 ft northeast of the discovery well. Simultaneously, preparations are being made to drill Simi 17, a "step out" well, approximately 2½ miles to the southeast.

Sunray Wildcat Producing

Sunray Oil Corporation has announced completion of a rank wildcat test producing at the rate of 5,000,000 cu ft of natural gas and 48 bbl of 68.2 gravity distillate a day in Harper County, Oklahoma. It is the E. M. Wolf No. 1, approximately 10 miles from nearest production. The well was drilled to 8245 ft in the Mississippi lime and plugged back with 5½-in. casing set at 7315 ft. Test was completed through a 1-in. choke.

New Gas-Condensate Find in Louisiana's Rank Wildcat

Texas Gulf Producing Company and Union Producing Company has a good gas-condensate discovery at a rank wildcat test in Terrebonne Parish, Louisiana. The well is the La Terre C-1, which flowed an estimated 6,000,000 cu ft of gas daily with 40 bbl of 47 gravity distillate a million cubic feet of gas. Flow is through a ¼-in. choke with casing perforations at 14,152 to 14,156 ft. The well is approximately 6 miles east of the De Large field, which is the nearest production.

Phillips Gets Two Wells In Stephens, Oklahoma

Phillips Petroleum Company has two new producers in Stephens County, Oklahoma. One is the Harry "A" No. 1, which flowed 175 bbl of oil in 6 hr through a ¾-in. choke. The other one is the No. 1 Chem-Doyle, which flowed 146 bbl of 35.9 gravity oil in 7 hr through a 48/64-in. choke and then flowed 144 bbl of oil in 6 hr through a ¾-in. choke.

Wilcox Sand Pool Seen In Mississippi Area

The J. Willis Hughes No. 1 Logan-Shields has indications of a new Wilcox sand oil pool in Jefferson County, Mississippi. The well had good oil shows in the 4600-ft zone, and was drilled to a total depth of 6652 ft. Casing was cemented at 4228 ft with a 1-hr drill-stem test taken at 4150-54 ft. Recovery was 240 ft of water cushion slightly cut with green oil.

In the American Tradition

PRESERVE YOUR FREEDOM!

American freedom, as outlined in the Declaration of Independence, is based on self-government—the ability of each of us to govern ourselves. Political government is meant to be only a balance wheel to prevent injustice and to preserve our God-given rights of life, liberty and the pursuit of happiness.

But when the power of our government is increased beyond this precise and restricted function, our individual liberties begin to disappear. Every grant of authority or power given to a political personality of any station . . . or to any political group, from the township through to and including the federal level . . . reduces our freedom.

Let's all strive to reverse the present trend towards more governmental power. Let's inform ourselves on the issues of the day . . . tell our political servants our views . . . and get back to governing ourselves.

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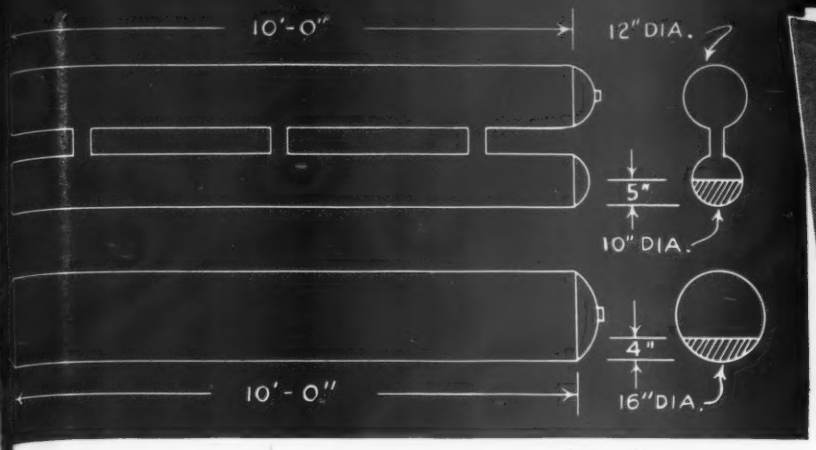
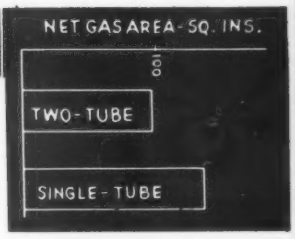


The Case in Favor of PARKERSBURG Single Tube Horizontal Separators

• The Parkersburg large Single Tube Horizontal Separator provides greater separating efficiency and other specific advantages over comparably priced double tube horizontal separators of equal nominal rating. These facts are substantiated by the accompanying area and capacity drawings of the two types of horizontal separators.

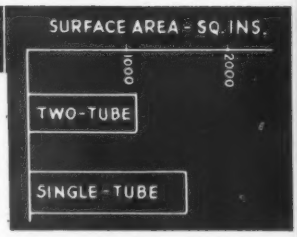
1. LARGE SINGLE TUBE PROVIDES GREATER AREA FOR GAS FLOW

eference to graph No. 1 shows the 16" single tube separator to have over 20% more gas area above the fluid level than in the upper tube of the two tube separator. The velocity of gas in this larger area is erefore as much as 20% lower than in the top tube of the two tube separator. Consequently, separation entrained liquid is more effective.



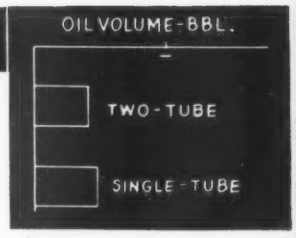
2. LARGE SINGLE TUBE HAS GREATER LIQUID SURFACE AREA

ur graph No. 2 shows the surface area is over 25% greater in the single 16" tube than in the bottom be of the two tube separator with oil levels as indicated by the two cross-section drawings. As a result this greater surface area, the oil comes into equilibrium more quickly and remains longer. Foam is more pidly dissipated. Degassing of the oil is more thorough and complete under these conditions.



3. LARGE SINGLE TUBE PROVIDES LONGER RETENTION TIME

he volume of oil retained in the large single tube Parkersburg Horizontal Separator is greater, at any iven rate of flow, than in the two tube separator. The retention time is therefore greater, giving the oil ore time to give up its gas. This is particularly important where foam exists and a layer of foam on top of e oil interface retards liberation of gas from the oil.



Other specific advantages of the Parkersburg large Single Tube Horizontal Separator are: Retention of gas in same tube with oil keeps the oil warm, and therefore the water warm, so that Parkersburg Horizontal Separators withstand lower atmospheric temperatures without danger of water freezing. With the single tube, there is only one tube to clean out. This single tube has three drains, and is open all along the bottom for a depth of about 2", to provide a clear area for forcing out mud and accumulation.

Ask your Parkersburg Representative for additional data about Parkersburg Horizontal Separators — or write for latest bulletin.

No. 5205

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Devon Leduc Well Flows At Rate of 1560 Bbl a Day

Devon Leduc Oils, Ltd. has completed an oil well in the D3 formation of the Stony Plains area near Calgary, Alberta, Canada. The well is flowing at the rate of 1560 bbl of 38 gravity oil a day, the company reported. This is Devon Leduc's eighth producing well here.

Spraberry Zone Extended

A new well has been drilled a mile west of Spraberry production in Dawson County, West Texas. It is Seaboard Oil No. 1 Dean, which flowed 160 bbl of oil a day from 6893 ft.

Intensified Oil Search Begins in East Pakistan

The search for oil in the thickly wooded area of Patiya, in Chittagong Hill Tracts, of East Pakistan began recently when the Chief Minister of East Pakistan, Noorul Amin performed the spudding-in ceremony of the first deep test-well of Pakistan Petroleum Limited in this Province.

Expressing the hope that oil be found, Noorul Amin said, "I fully share the company's hope and belief that deep below the subsoil of this spot where we are all assembled oil in commercial quantities will be struck."

J. M. Huber Well Opens Texas Panhandle Oil Pool

The J. M. Huber Corporation is opening its No. 1 Pazoureck, discovery well in Ochiltree County, the Texas Panhandle. Total depth is 8096 ft, with pipe set on bottom. From perforations in the Atoka sand at 8031-36 ft it tested 1,500,000 ft of gas a day, and after Hydrafrac it did 6,000,000 ft of gas through a ½-in. choke. The last perforating job was done at 8019-60 ft, and crews tested 33 bbl of oil and 1,500,000 ft of gas a day through a ¾-in. choke, through a separator.

Wilshire Well Opens New Mexico Field

Wilshire Oil Company has opened a new oil field in Lea County, New Mexico. The well, the No. 1 Townsend, has been drilled to a total depth of 13,083 ft, with hole plugged back and pipe perforated in Pennsylvanian at 11,370,-440 ft. After acidizing with 15,000 gal, the wildcat swabbed 131 bbl of oil in 13 hr.

Montana Wildcat Set

Cities Service announced location of a wildcat in Montana. It is Government No. 1, an 8500-ft test on the company's 1800-acre West Dry Creek block in Carbon County, Montana. Principal objectives are the Eagle, Frontier, and Dakota sandstones, the Pryor conglomerate, Morrison sandstone, Phosphoria limestone, Tensleep sandstone, and Madison limestone. The test is one mile northwest of production in the Dry Creek pool.

Permian Basin Pool Opened

Phillips Petroleum Company has completed an Ellenburger discovery in the Permian Basin, Andrews County, West Texas. The well is the company's 1-EE University of Texas, and has been given a calculated daily flow of 1498.2 bbl of 43.9 gravity pipe line oil. On an 8-hr test 499.4 bbl of oil were recovered daily through a ½-in. tubing choke with perforations between 10,884-918 and 10,-938-978 ft. Casing of 5½ in. was set at 11,003 ft, with the total depth of the well placed at 11,065 ft.

West Texas Discovery

An Ellenburger discovery, the No. 1 James Davidson, has been brought in in Scurry County, West Texas, by Humble Oil and Refining Company. The well was completed for a 24-hour flow of 314.98 bbl of 41 gravity oil through a ¼-in. choke. Flow is from 7490 to 7608 ft, with a gas-oil ratio of 560-1.

Oklahoma Field Found

Carter Oil Company and others have a new gas-distillate field in Ellis County, Oklahoma at their No. 1 Rosendale. The well gaged 25 bbl of distillate in 18 hr through a ¾-in. choke. Gas-oil ratio was 65,200-to-1. Production is from the Morrow sand at 8455-510 ft.

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THREE SETS OF CUTTERS are held in expanded position against the casing circumference by means of heavy springs . . .

CUTTERS ARE SPACED so as to overlap in their contact with the casing, provide the most effective and efficient cutting action, give better fluid return path . . .

HELICAL DESIGN of the hard-faced cutting edges provides an efficient shearing-cutting action that completely removes burrs and foreign material from the casing wall . . .

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EITHER TUBING OR WIRE LINE can be used for running the Grant Vertical Scraper, and full circulation can be established through the tool if necessary.

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Casing Scrapers	Bulletin No. 17
Underreamers (Rotary)	Bulletin No. 24
Underreamers (Cable Tool)	Bulletin No. 27
Hole Enlargers	Bulletin No. 38
Reamers	Bulletin No. 43-A
Hydrostatic Perforation Cleaners	Bulletin No. 50
Dump Bailers	Bulletin No. 51
Roller Cutter Shale Bits	Bulletin No. 54
Sand Pumps	Bulletin No. 55
Well Cleanout Equipment	Bulletin No. 57
Wall and Bottom Hole Scrapers	Bulletin No. 58
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Write for Descriptive Bulletins on these Grant Tools

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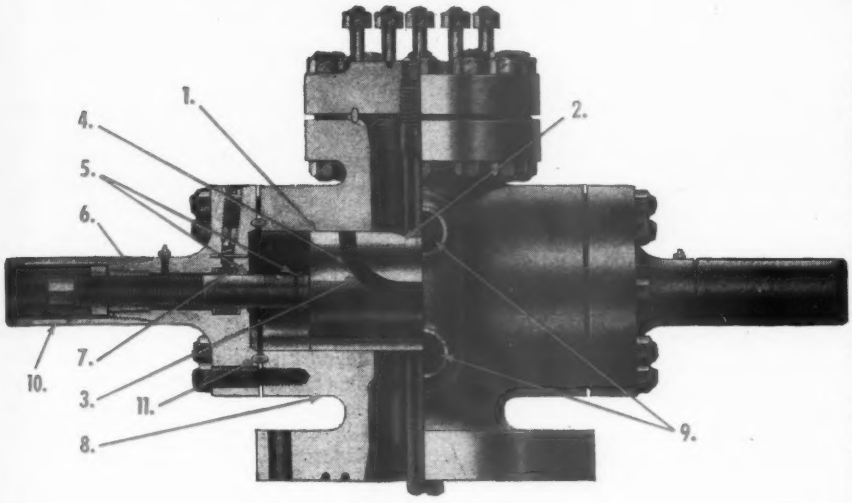

● It takes all of these "Points of Superority" to give you everything you expect . . . and more . . . in service and performance from a ram type tubing head. That's why every one has been incorporated in the Rector Type CRS Round Ram Tubing Head.

They make the Type CRS the most efficient ram type tubing head you can install. You have a dependable, leak-proof seal for the life of the well. Rams operate smoothly and easily even after long standing. Placement of side outlets assures most convenient hook-up arrangement. Three methods of tubing suspension and stripper bowl interchangeable on the body assure flexibility to meet changing well conditions.

When installing a ram type tubing head, specify the Rector Type CRS Round Ram Tubing Head to get better service and performance. Ask your Rector Representative or authorized supply store.

POINTS OF SUPERIORITY

1. ROUND RAMS
Mud cannot accumulate on top to obstruct movement. Greater strength for suspending longer strings.

2. TWO-PIECE RAMS
Upper front segment is secured to main body by shoulder screw. One-piece, pre-formed oil resistant packing is inserted between the two segments. Packing is not under pressure while ram is being moved.

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When rams are closed upper segments and packing make first contact, forcing packing into pressure-tight seal with ram cylinder and around tubing.

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permits equalized pressure on under side and back of rams without ports or by-passes.

5. VALVE SEAT
in end flange and valve face on ram screw, seat when rams are drawn back; prevents well fluids from fouling ram screw.

6. THREADED BRONZE BUSHING
for ram screw eliminates steel-to-steel thread contact . . . assures easy movement of rams.

7. PLASTIC PACKING
around ram screws, between "V" retainers, assures pressure-tight seal.

8. STRONGER BODIES
with less weight made possible by round rams.

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threaded or flanged, provided above or below rams or one above and one below.

10. RAM SCREW PROTECTOR
can be used when rams are opened or closed.

11. RAM BONNET
sealed to body with API ring gasket.

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Running tour with men in the industry

R. E. Cox

J. J. Lienhard

Paul J. Nicholson

C. V. Helm

R. E. Cox has been named assistant vice president and assistant secretary of The Western Company and two new men have been added to the administrative staff of the company's general office in Midland, Texas, C. L. Glass, vice president and secretary-treasurer has announced.

The new men are **J. J. Lienhard** who has joined the company as comptroller and **Paul J. Nicholson,** who fills the newly created position of manager of the general office. Cox, in his new capacity, will be in charge of the oil and gas well servicing company's budgeting and special financial projects and reports. Lienhard, as comptroller, will be responsible for all accounting and accounting procedures. Nicholson will handle insurance matters, and other assignments as well as the management of the general office.

C. V. Helm has been named special assistant to Walter Beadle, vice president of operations for Western. He will work on various operational projects and assist Western's employee relations department. He is a graduate of the Thayler School of Engineering at Dartmouth College. Before being transferred to Midland Helm was manager of the company's acidizing station at Ulysses, Kansas. He is succeeded at Ulysses by **Harold Parsons** who formerly was district engineer for Western's South Permian Basin district with headquarters in Odessa.

E. E. Beeman, district geologist for Wyoming, The Texas Company, has been transferred to Lewistown, Montana, replacing **K. R. Parsons** as district geologist, who has resigned.

A. O. Saterdal, district geologist for Western Colorado and Utah, will be transferred from Salt Lake City to Casper, Wyoming, replacing Beeman. **R. E. Hunt** has been promoted from geologist to the division office at Denver to district geologist at Salt Lake City.

Beeman graduated in geology from the University of Minnesota in 1939 and, following four years' service in the Army, joined Texaco in 1946 as geologist in Casper.

After receiving his geological degree from the Montana School of Mines in 1945, Saterdal joined Texaco. Since 1949, he has been district geologist in Craig, Colorado, and Salt Lake City. Hunt received his doctorate degree in geology at Ohio State University in 1950 and until January of this year was geologist in the Casper district office.

Willard M. (Butch) Payne, consultant with the firm of Harris and Payne, geologists, has moved his office to Naples, Florida, and will operate from there. Home office in Jackson, Mississippi will be headed by **R. Merrill Harris.**

A. F. Barrett, Rocky Mountain manager, General Petroleum Corporation, Casper, Wyoming, was named chairman of the Rocky Mountain district of the American Petroleum Institute's division of production at the conclusion of the seventh annual meeting recently.

Other officers elected for the coming year were, **Claude Peavy,** Phillips Petroleum Company, Denver, vice chairman for Colorado; **C. L. Cooksey,** Carter Oil, Vernal, vice chairman for Utah; **H. B. Gernert,** Trigood Oil Company, Casper, vice chairman for Wyoming; **R. D. Smith,** Union Oil, Great Falls, vice chairman for Montana. **H. H. Healy,** Ohio Oil, Casper, was named vice chairman at large. **S. J. Lintzenich,** Hughes Tool Company, Casper, is the new secretary-treasurer. Retiring district chairman **C. H. Griffin,** Phillips, Casper, was made head of the advisory committee.

Citations for Service were awarded by J. C. Donnell, II, president Ohio Oil Company, to **Hugh A. Stewart,** PAD, Washington; **J. F. Cullen,** Stanolind Oil and Gas Company, Casper; **Z. K. Brinkerhoff, Jr.,** Brinkerhoff Drilling Company, Casper; and **Irving Garbutt,** former oil editor, the Casper Tribune-Herald.

J. A. Cleverly of Bartlesville, Oklahoma, has been named manager of the production division, Cities Service Oil (Delaware) succeeding **M. J. Kirwan,** who will retire but will continue to act for the company in a consulting capacity. **C. E. Beecher** of Bartlesville, who has been general superintendent of the division, will become director of production research and development. **C. R. Smith,** who has been assistant division superintendent at Odessa, Texas, will be transferred to Bartlesville as general superintendent of the division.

Kirwan's retirement comes after almost 45 years in the field of oil and gas production in the United States and the Orient, beginning back in 1908 when he was field engineer for Associated Oil.

Cleverley, the new production division manager, is a long-time Cities Service employee, entering company service in 1920 as a junior engineer. He has served in various executive capacities in the company's oil production division at Oil Hill, Madison and Russell, Kansas, and Oklahoma City. He was transferred to Bartlesville in 1948 and later was made assistant general superintendent.

Smith, who is being transferred to Bartlesville as general superintendent, is a 25-year man with Cities Service. He began his Cities Service career as a junior engineer and served as production engineer and in other capacities at Seminole, Oklahoma City, Bartlesville, and Odessa.

Max S. App, vice president and director of production for the General Petroleum Corporation, received congratulations from the corporation's executive committee upon his completion of 40 years service recently. App joined General Petroleum in 1912, at Taft, California, as an engineer when the company itself was only a few months old.

Paul L. Lyons, manager of exploration, Anchor Petroleum, has been named president of the Geophysical Society of Tulsa. He is also editor of "Geophysics" the quarterly publication of the Society of Exploration Geophysicists. Other officers include:

L. Y. Faust, Geophysical Research Corporation, first vice president; **W. B. Agocs,** consultant, second vice president; **D. R. Davis,** Industrial Electronic Supply Company, secretary; and **Francis H. Cady,** Carter Oil Company, treasurer. **E. V. McCollum,** E. V. McCollum and Company, is the society's new district representative to the national society. **Reese H. Tucker,** Cities Service Oil Company, and **R. G. Piety,** Phillips Petroleum Company, remain directors to the national society.

George E. Burton formerly Sun Oil Company geologist has announced offices in Gainesville, Texas. Retired from Sun Oil, Burton first came to the southwest as assistant director of the Oklahoma Geological Survey at Norman, Oklahoma. He reports he specializes in geological engineering.

What's NEW

In Perforating, Testing, and Fishing Tool Services

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Latest News About New Tools, Techniques and Services

New Glass Jet Perforators

SOLVE

Production Problems

— After all other methods fail to get results!

EXCERPTS FROM RECENT McCULLOUGH FIELD REPORTS

PRODUCTION PROBLEMS	SOLUTION
1. NEW WELL, POOR PRODUCER. Well only produced 6 B/D after being perforated several times by other types of perforators. One string of 5½" 15# casing heavily cemented. Operator about to abandon well.	Production increased from 6 B/D to 90 B/D with McCullough Glass Jet Perforator and Steel Strip Carrier. Due to these results oil operator planning to reperforate five other wells in same area with same history, and with the McCullough Glass Jet Perforator, of course.
2. DOG LEG. Operator pulled derrick in while running pipe, dropped casing causing dog leg at around 7,000'. Solid type perforators could not pass through kinked section. 5½" 17# casing, full of 11.5# mud, cemented.	McCullough Glass Jet Perforator and Steel Strip Carrier, although same O.D. as other perforators, easily passed through dog leg bringing in exceptionally good well.
3. SLOTTED CASING. Well had been washed several times without increasing production of 26 B/D through 5½" 17# slotted casing.	McCullough Glass Jet Perforator and Steel Strip Carrier increased production from 26 B/D to 59 B/D.
4. SHOT WITH NITRO. Well previously shot with nitro. Production of 250 B/D comparable to other wells in same area also shot with nitro. Open formation, hard sand.	McCullough Glass Jet Perforator and Steel Strip Carrier increased production from 250 B/D to 1004 B/D.
5. NEW WELL, NO PRODUCTION. Perforated several times by other types of bullet and largest jet perforators without results. 5½" 15# casing, squeeze cemented several times.	Combination McCullough Glass Jet Perforator and Steel Strip Carrier and McCullough Burrless Bullet Perforator. Production of 37 B/D obtained.
6. DRILL PIPE. Operator used 4½" drill pipe instead of casing. Other types of jet perforators carried such light loads of explosives maximum penetration could not be achieved.	McCullough Glass Jet Perforator and Steel Strip Carrier obtained same maximum penetration and maximum hole size as normally obtained only in regular sizes of casing. Result: A good gas well.

IT PAYS TO DISCUSS YOUR PRODUCTION PROBLEMS WITH A McCULLOUGH SERVICE ENGINEER. It pays in more ways than one, because perforating is not simply a matter of shooting holes. Every oil well represents a different perforating problem—a challenge.

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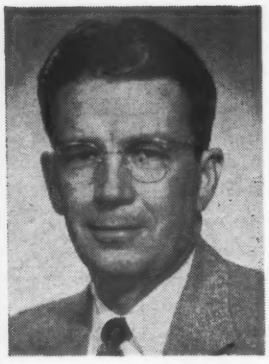
CANADA: Edmonton, Alberta; Calgary, Alberta; Regina, Saskatchewan
VENEZUELA: United Oilwell Service Co., S. A.; Caracas, Anaco, Maracaibo

SERVICE LOCATIONS: TEXAS: Houston, Snyder, Alice, Cisco, Corpus Christi, McAllen, Odessa, Tyler, San Angelo, Victoria, Wichita Falls. **OKLAHOMA:** Oklahoma City, Guymon, Healdton. **MISSISSIPPI:** Laurel. **NEW MEXICO:** Hobbs. **KANSAS:** Great Bend. **WYOMING:** Casper. **CALIFORNIA:** Los Angeles, Avenal, Bakersfield, Ventura. **LOUISIANA:** Houma, Lake Charles, New Iberia, Shreveport. **COLORADO:** Sterling. **NORTH DAKOTA:** Williston. **UTAH:** Vernal.

To obtain more information on products advertised see page E-51

W. L. Morrison

E. J. Hammer



John S. Bell

W. L. Morrison has been named production manager for El Capitan Oil Company, W. M. Osburn, vice president and general manager, has announced. **Edmund Borys** has been named manager of exploration, **R. C. Senning,** has been named staff assistant to the general manager and **J. T. Miller** has been made a landman in the exploration department of El Capitan.

Morrison has had wide experience in the oil business both in the United States and South America, and before joining El Capitan he was assistant to the president of George P. Livermore, Inc., in Lubbock. Borys has been with El Capitan for about a year as exploration geologist. As manager of the exploration department, he will supervise all of the company's exploration activities. He previously was with the Hunt Oil Company in Dallas.

E. J. Hamner has been named manager of Humble Oil and Refining Company's operations in California. **John S. Bell** was appointed assistant manager for California.

The organizational changes were brought about by the increasing importance and wide variety of Humble's activities in California. Hamner and Bell will have full responsibility for all California operations with **Hunter Yarbrough** as area geologist in direct charge of exploration matters and **Lawrence H. Byrd** as area production superintendent in charge of drilling and producing.

Hamner attended Texas A & M College for two years, was graduated from the University of Oklahoma. He joined Humble upon his graduation, beginning as a truck driver and then roustabout. In December 1948 Hamner went to California as manager of exploration where he has remained.

Bell, assistant manager for California, is a graduate of the University of Oklahoma. He joined Humble in 1933 as a rotary helper and was made district petroleum engineer for Southwest Texas in 1934. In 1951 he went to California as district superintendent.

Yarbrough, area geologist, is a graduate of the University of Texas with a BS in geology. He joined Humble in 1940 as a junior evaluation geologist. He went to California in 1948 where he has remained. Byrd, area production superintendent, is a graduate in chemical engineering from Texas A & M. He joined Humble as a roustabout in 1937 and worked in East and Southwest Texas and the Gulf Coast. In 1948 he was made assistant district superintendent at London, Texas, and in 1951 went to Los Angeles as assistant district superintendent.

Michael C. Brunner of Midland, Texas, has been named assistant director of the Production Division of the Petroleum Administration for Defense, succeeding **Don R. Teis,** Deputy Petroleum Administrator Bruce K. Brown announced. Teis has entered the employ of the Lawton Oil Corporation in Magnolia, Arkansas.

Graduated from the California Institute of Technology in Pasadena, where he received his BS in civil engineering, Brunner worked for a short time for Bethlehem Steel Corporation in Pittsburgh, and in Los Angeles. In 1926 he went to work for the exploration department of Shell Oil Company and held various engineering positions before being named assistant to the president in San Francisco. He was named production manager of the Midland area in 1948.

Teis, whom he now replaces, was graduated from the University of Oklahoma with a degree in petroleum engineering in 1933, then joined the Phillips Petroleum Company as a production engineer.

In 1947 he joined Creole Petroleum Corporation and at the time he became a member of the PAD staff in 1951 was supervisor of Creole's materials division in Caracas, Venezuela.

D. G. Kingman, San Joaquin, California, division superintendent of General Petroleum Corporation's production department, has been advanced to the post of assistant manager of joint venture operations.

This was announced by Max S. App, General Petroleum vice president and director of production. Kingman will be stationed at the Los Angeles headquarters of the company. He has spent 14 of his nearly 20 years with General Petroleum in the San Joaquin region. He became division superintendent in 1944. He is a graduate of the California Institute of Technology.

John J. Oliphant has been advanced to the post of superintendent, San Joaquin division, of General Petroleum production department, replacing Kingman. Since 1948 Oliphant has been production superintendent of the San Joaquin division. **J. F. Bohns** has been named to succeed Oliphant as production superintendent.

A graduate of the University of Utah, Oliphant has had over 20 years service with General Petroleum in engineering and supervisory positions. He is a member of the American Institute of Mining and Metallurgical Engineers and the American Petroleum Institute.

Bohns, who recently completed 40 years service with General Petroleum, all of it in the San Joaquin Valley, has been production foreman at the company's Lost Hills properties.

Kenneth R. Joynt has been promoted from assistant district superintendent of Magnolia Petroleum Company's Vanderbilt, Louisiana, producing district to district superintendent. In that position he succeeds the late **C. G. Worthy** who died after an extended illness. **Louis M. Ayers** has been promoted to production foreman in the company's La-Gulf district to district superintendent of that district with headquarters at Morgan City, Louisiana.

Basil Moss has been transferred from Mt. Vernon, Illinois, to New Orleans, Louisiana, as a land man for Magnolia. There he will be in charge of the New Orleans district, which has been newly created and which comprises 22 counties in southern Louisiana.

Dan Kralis and **J. C. Stamm,** co-owners of Geological Well Service Company, Abilene, Texas, have announced the opening of 3 division branches with **Bill Garms** as manager of the Rocky Mountain division at Denver, Colorado. **E. G. "Ty" Dahlgren,** oil and gas consultant, Mid-Continent division agent, Oklahoma City, and **Forrest Kinser,** field representative for Fort Worth with temporary address at Grand Prairie.

The following additions are also announced, **Earl Komie,** research geological engineer, who just completed his Master's degree at the University of Texas, **James Herold,** geologist, **John Post,** laboratory geologist, **Louis MacGregor,** laboratory geologist.

M. L. Haider, Imperial Oil, Ltd., director and vice president, has been named deputy co-ordinator of the producing activities of Standard Oil (New Jersey) with headquarters in New York.

A Stanford University graduate, Haider became a research engineer in the field of natural gas in 1927, becoming associated with an affiliate of Jersey Standard in 1929. He was named head of the production research and engineering department of the Standard Oil Development Company in 1938. In 1945 he transferred to the Standard Jersey producing department. He went to Imperial in 1946 as head of the company's producing department.

T. W. Legatski, Phillips Petroleum Company, sixteenth recipient of the Hanlon award, highest NGAA award.

Sumner Pike, recently of the Atomic Energy Commission, reviewed atomic energy potential.

Henry J. Taylor, radio analyst and journalist, addressed the general session.

Hines H. Baker, president, Humble Oil and Refining, spoke on "Our Greatest Asset."

Guy C. Kiddoo, vice-president, First National Bank of Chicago, addressed general session.

Atomic Energy Not Ready for Competition

Present fuels must fill supply within foreseeable future, Natural Gasoline Association of America is told by former commissioner—other subjects also concern annual convention

ARCH L. FOSTER*

NATURAL gasoline, petroleum, and other fuel industries have nothing to fear from atomic energy within the foreseeable future, according to statements made by Sumner Pike, ex-Atomic Energy Commission executive before the annual meeting of the National Gasoline Association of America, held in Houston, Texas, April 30 to May 2. Certain applications may become feasible in the near future, but general adaptation of atomic energy to the power needs of the world cannot be foretold now, Pike indicated.

This was only one of the more than 20 subjects of wide industry interest discussed before this biggest of all NGAA meetings in Houston. In fact, this meeting sparked by indefatigable Secretary W. F. (Bill) Lowe drew more than 1600 natural gasoline and similarly interested men from the whole country, to discuss the industry's rapidly growing list of overshadowing problems. These subjects included problems of transportation, underground storage, personnel training, credit and financing, technical, engineering and operational developments, and the prospects for future expansion of the industry.

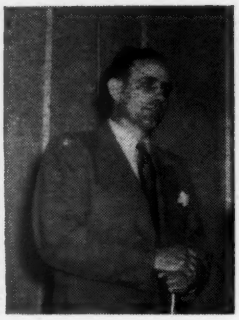
In the submarine of tomorrow the atomic energy prime mover undoubtedly has an important place, Pike indicated in discussing the most promising applications of atomic energy. The most important drawback to the atomic energy power plant is the enormous weight of the shielding, (metallic lead,) necessary to protect personnel especially from the lethal radiations. This drawback militates against its use in any moving unit or vehicle, but for submarines this weight disadvantage is overridden by the small weight and space requirements of the engine itself, and its fuel, and the advantage of extremely long cruising range, due to small fuel requirements. Similarly, atomic power units may become practicable in large seagoing ships, again in spite of great weight of shielding required. Also, very long range airplanes of large capacity may be fit units for atomic energy in the not distant future, it was indicated. Nothing appears on the horizon for automobiles, trucks, and similar equipment on account of cost, weight, and numerous other deterrents, Pike said. One possibility for reduction of cost is the production of byproducts that may be sold to the government, such as plutonium or other isotopes. These isotopes have lethal radiations and thus involve the expenses and precautionary measures imperative for handling such products. An electric generating plant powered by atomic energy will cost five times as much as one of the same capacity using gas, coal or petroleum as fuel, "and will be obsolete before it runs," Pike stated in summing up the prospects.

The natural gasoline, and other industries "will prosper and you will enjoy the fruits of your labor only if we maintain the liberties and safeguards and freedom of opportunity that have brought industrial development and a standard of living unknown elsewhere in the world," is the pronouncement of Guy C. Kiddoo, vice president of the First National Bank of Chicago, in discussing the matters of credit, financing, and profits for the industry, a field in which Kiddoo is an authority. Profit margins may be smaller than in pioneering days in the industry, but new fields are opening up that offer great possibilities for aggressive, forward-looking management. The first essential looked for in an industry or a company, when considering the matter of credit for a natural gasoline plant is honest, courageous, and skilled management, Kiddoo said. Good labor relations are necessary; profit sharing, pension plans and other policies are a part of good management. In 1951 plant costs for natural gasoline plants were more than twice those for 1930; product prices were only 7 per cent higher. In the middle '20's only $10,000 to $15,000 investment was needed to provide a plant job. Now $100,000 to $175,000 is needed to insure that same plant job,

*Editor, Refining and Gas Processing.

EXCLUSIVE

Rex Lane, above, and B. J. Thompson of Warren Petroleum, delivered a paper at Operations Forum.



Charles W. Miller, Midland Gasoline Company, Houston, was chairman of the Operations Forum.

B. J. Thompson with Rex Lane gave a paper, "Absorption and Dry Distillation."

John Eichelman, El Paso Natural Gas Company, spoke on "Gas Turbine Driven Compressors."

I. Earl Nutter, Panoma Corp., Amarillo, discussed "Trends in Fractionation."

it is found. Levelling the curves of supply and demand is aided by greatly increased storage for natural and LPG products; in this connection reference is made later to new advances in underground storage for especially LPG, an outstanding contribution to the solution of this seasonal storage problem.

It will require longer to recover our investments in natural gasoline than was the case in earlier years, the banker stated. Our dollar of 5 years in the future is worth only 78 cents now; wait 10 years and it is worth only 61 cents. Under existing conditions little if any money can be had from banks for periods longer than 5 years; a combination bank and insurance company loan is the best bet. The bank's money can take care of the construction period and provide flexibility in operations. The insurance company assured of experienced bank support will handle the longer term loans.

A better idea of the tremendous importance of proper training of gas and gasoline analytical personnel is obtained by considering the monetary value of errors when projected to cover the huge quantities of product or material that may be involved, Joe Wood, chairman of the NGAA technical committee emphasized in discussing the details of training analysts. The accompanying table of results of errors on small samples translated to cover 60,000,000 cu ft of gas show how serious these slips are. Note that the error of only one-half of a mole per cent in pentane content amounts to $4500 per year, with other small errors amounting to more than $100,000. An error of only one millimeter of mercury (about 0.04 in.) in reading pressure on a 3-liter flask costs $25,000 annually on one 3-component (product) type analysis. For a 5-product analysis the cost (loss) is nearly $60,000 per year, on 60,000,000 cu ft per day operations.

TABLE 1.

Construction Cost:	
Change from 10 in. vacuum to 10-lb pressure.	
Gathering system	$ 72,000
Compressors	900,000
Operation	
0.5 GPM error on propane content Oil circulation	24,000 per year
0.1 GPM error pentanes missed in residue	105,120 per year
10% Iso-butane in 26-lb gasoline	18,000 per year
0.5 Mole per cent error in pentane content of 80,000 gal daily delivered gasoline	4,500 per year

Basis: 60,000 MCF daily.

The general location of underground (LPG) storage must be chosen with respect to production, transportation, and consumption of propane and butane fuels, says R. L. Loofbourow, manager of the mine construction department of E. J. Longyear Company. The site must be a tight, strong rock, or if a permeable rock some means of sealing must be available. Concrete is not impervious, must be surface-treated, and may cost as much as $2 per barrel of storage capacity. Military experience has shown advantages in Thiokol latex surface coverings, but no data are available to show if this material is useful on rock; more research on this point is necessary to offer a satisfactory solution. Under present conditions tight rock is the only proper solution, the author decided.

In multiple fractionation of a raw product it is better to use intermediate separation, followed by individual separation of a binary mixture in each case, than to fractionate consecutively each product from the charge, I. Earl Nutter of Panoma Corporation stated in essence in discussing modern trends in fractionation in the industry. Equipment maintenance may be held to a low figure by selecting equipment properly, conditioning cooling water carefully and constantly. The greatest efficiency and the maximum capacity of any fractionation system is attained only by use of ample and good instrumentation, properly applied to the entire system, Nutter stated. To illustrate his points and to show how a modern fractionation system is designed and operated Nutter discussed his company's large plant in the Oklahoma Panhandle.

T. W. (Ted) Legatski is the sixteenth recipient of the Hanlon Award, highest honor which can be bestowed by the Natural Gasoline Association of America. He received this award at the 31st annual meeting of the Association in Houston, April 30-May 2, 1952. Graduate of the University of Michigan. Legatski literally grew up with the natural gasoline industry with Phillips Petroleum Co., and is known as one of the outstanding world authorities on light hydrocarbons, their processing, properties and utilization. The Hanlon Award is granted annually for important contributions to the natural gasoline industry. * * *

T. L. Legatski, left, receives the Hanlon award from J. F. Lynch, president of NGAA.

The Arosorb Process in Refinery Operations‡

Several silica-gel beds are employed in a cyclic operation involving successive adsorption and desorption steps

W. H. DAVIS,* J. I. HARPER† and E. R. WEATHERLY†

THE Arosorb process is an outgrowth of the successful use of silica-gel adsorption as an analytical method for separating organic compounds. The analytical method was developed extensively in connection with API Research Project 6, and since then has proved to be a highly useful procedure in most petroleum laboratories. In the analytical method the gel is discarded after each test, as the relatively low cost of the gel does not warrant regeneration. In any commercial application of silica gel for selective adsorption, discarding the gel or regenerating with heat to drive out the contained hydrocarbon or organic liquid would be prohibitively expensive. In 1943, however, an idea was developed by Sun research chemists for operating a silica-gel bed in a cyclic manner. First the bed is used for adsorption, and then is desorbed with a suitable liquid, leaving the gel in condition for re-use in the next cycle. This basic idea, modified and improved over the years, has resulted in a new commercial process called the "Arosorb process".

The Arosorb process actually is not merely another process, but a new refining tool in the sense that distillation, solvent extraction, and other techniques are available tools to the refiner. Although the process has been developed primarily for the separation of aromatics from various refinery streams, it can be applied to the separation of other materials such as olefins, non-hydrocarbon organic liquids, or any separation where silica gel has a selective-adsorption affinity for one or more of the component liquids in the system.

Description of Process

This paper is designed to show what the Arosorb process can do for a refiner and what the costs will be to obtain various results. Therefore, relatively little space can be devoted to the technical aspects of the process, but a few words along this line are in order.

The silica gel used is manufactured commercially by the Davison Chemical Corporation, and consists of granular particles ranging from 28 to 200-mesh. This material is used in one or more cases, or gel beds, which have diameters of 3 to 10 ft and heights of 15 to 25 ft. Inasmuch as the cycle time for a gel case runs from one to two hours, it is advisable to operate several cases suitably staggered in flow pattern in order to smooth out the overall flow of liquids through the system.

The desorbent used in any particular operation is chosen from the same chemical type as the material being selectively adsorbed from the charge stock, but has a sufficiently different boiling point to permit subsequent separation by distillation. This leads to two basic types of operation.

Operation on Low-Boiling Stocks. The scheme used for relatively low-boiling charge stocks consists of employing a desorbent higher boiling than the charge. This type of operation is shown in Fig. 1, which is a much simplified flow sheet of a unit charging 2500 bbl per day of catalytic reformate for the production of nitration-grade benzene and toluene. The charge stock is pretreated by passing it over activated alumina or other suitable material for the removal of water and other gel poisons, and then passes into one of several silica-gel cases for a period of 30 min. The charge is then diverted to another case, and the first case is fed with desorbent for a period of 70 min, at the end of which time the gel is ready to receive charge again.

In the following discussion the terms "charge saturates" and "charge aromatics" refer, respectively, to the saturates, i.e., the paraffins and naphthenes, originally present in the charge and the corresponding aromatics originally in the charge stock. As the charge stock passes down through the bed, the charge aromatics are adsorbed, leaving the bulk of the charge saturates in the voids around the gel particles. The desorbent, which consists of a crude xylene stream containing about 65 per cent xylenes, pushes the saturates out of the silica-gel bed and displaces the charge aromatics adsorbed on the gel.

The effluent from the bed is divided three ways. The effluent containing the charge saturate goes to a tower, T-1, for recovery of the saturate product overhead and desorbent as bottoms, the latter being returned to the system for reuse. The next portion of the effluent may be recycled to the charge stream if particularly high-purity products are desired, as discussed in more detail later. The final portion of the effluent containing the charge aromatics flows to a fractionator, T-2, for recovery of the aromatic product as overhead and the desorbent again as bottoms. The fractionator, T-3, shown in the flow sheet is simply a benzene-toluene splitter.

Fig. 2 is a composition diagram of the effluent from a gel case during one complete cycle. Although the overall desorbent stream contains 65 per cent xylenes and 35 per cent saturates of about the same boiling range as the xylenes, the composition of the desorbent in the effluent varies substantially during the cycle. Note that, at the beginning of the cycle, the effluent consists wholly of desorbent which is of normal composition. As the cycle progresses, the charge saturates become a major portion of the effluent and the desorbent part is mainly aromatics. Later in the cycle the charge saturates disappear as the charge aromatics begin to show up in the effluent. During this period the desorbent saturates are present in a higher proportion than normal, relative to the desorbent aromatics. At the end of the cycle the effluent again is wholly desorbent of normal composition.

The effluent between the two vertical dashed lines contains the only overlapping of saturate and charge aromatics, and this may be recycled to obtain maximum recovery of high-purity aromatics. The purpose of the saturate component of the desorbent is to provide the wedge of desorbent saturates between the charge aromatics and charge saturates, as shown in Fig. 2, and to reduce the total aromatic content of the recycle stream.

Operation on High-Boiling Stocks. The other type of operation, shown in Fig. 3, is used for relatively high-boiling charge stocks such as kerosine or catalytic gas oil. In this instance a 35:65 pentane-toluene mixture, which boils below the charge, is used as the desorbent. In addition, pentane is employed to reduce the viscosity of the charge. Choice of pentane here is merely a matter of

‡Presented before the mid-year meeting of the American Petroleum Institute's Division of Refining, San Francisco, California, May 14, 1952.

*Process engineer, Sun Oil Co., Philadelphia, Pennsylvania.

†Process development engineer, Sun Oil Co., Marcus Hook, Pa.

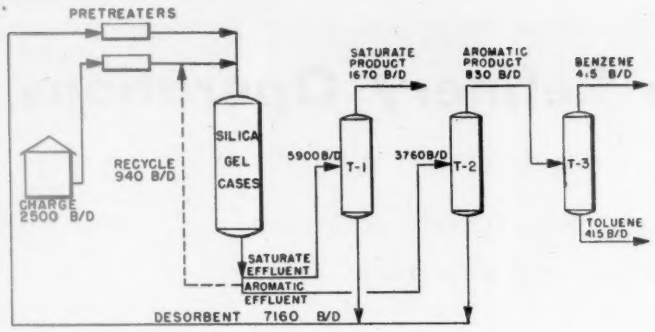


FIG. 1. Flow sheet of typical Arosorber operation, using desorbent heavier than charge.

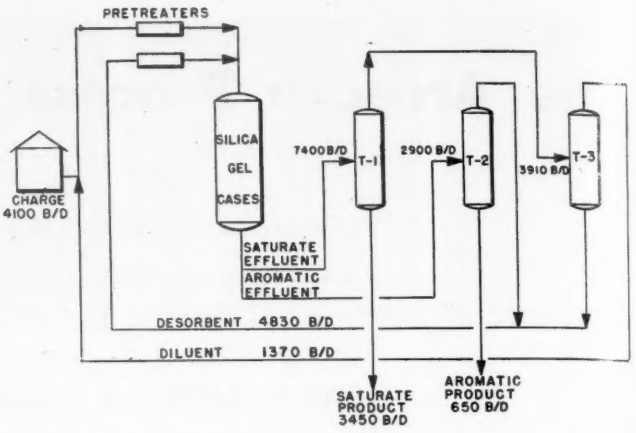


FIG. 3. Flow sheet of typical Arosorber operation, using diluent and desorbent lighter than charge.

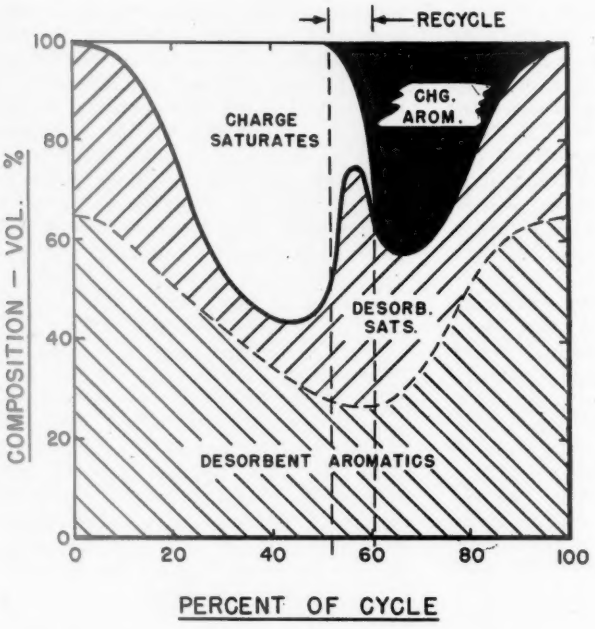
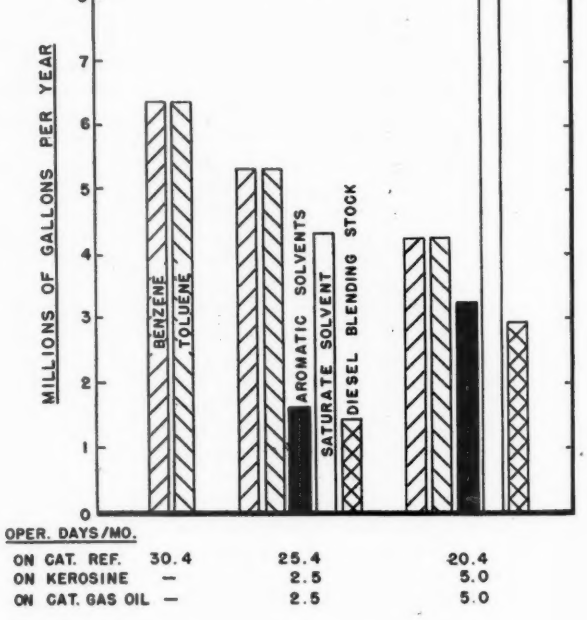


FIG. 2. Effluent composition diagram, one complete cycle.



OPER. DAYS/MO.			
ON CAT. REF.	30.4	25.4	20.4
ON KEROSINE	—	2.5	5.0
ON CAT. GAS OIL	—	2.5	5.0

FIG. 4. Diversified operations for Arosorber II.

convenience in describing the process; any low-boiling saturate fraction is suitable.

The flow sheet in Fig. 3 represents the same plant discussed in connection with Fig. 1, but is now shown operating on a typical charge stock in the kerosine boiling range. The kerosine plus the pentane diluent is pretreated, and flows to one of the gel cases for a period of about 80 min. This is followed by the desorbent for another 70 min to complete the cycle. The saturate and aromatic effluents again flow to fractionators T-1 and T-2, respectively, but now the toluene desorbent and the pentane diluent are taken as overhead streams, leaving the saturate and aromatic products as bottoms. The pentane-toluene overhead from T-1 is fed to T-3, which was the benzene-toluene splitter in the other operation, in order to recover the pentane diluent for re-use. This separation is not required on the overhead from T-2 because pentane is a component of the desorbent.

The effluent diagram for this operation would be similar to Fig. 2, the pentane diluent appearing partly in the charge saturates and partly as desorbent saturates. Recycle could be employed if desired, but extremely high-purity products normally are not required in kerosine and gas-oil operations.

Character of Products from Typical Operations

Thus far the highlights of two general methods of operating the Arosorb process have been presented. The next step is to see what results can be obtained with the use of the highly flexible Arosorb process on a wide variety of stocks. The characteristics of the products which can be produced from various refinery streams are covered in the following discussion and accompanying tables.

Benzene and Toluene. Table 1 shows the nitration grades of benzene and toluene and the saturate product produced from processing a suitable cut from catalytic reformate. The charge to the Arosorber contains 35 per cent of aromatics, consisting of equal amounts of benzene and toluene. The benzene and toluene products shown in Table 1 represent material recovered directly from the Arosorber without any finishing step. The two products meet nitration-grade specifications except for the acid-wash color. The acid-wash color of the benzene is reduced to less than 1, and the bromine index to about 4, by a comparatively light acid treatment. The toluene responds to treatment with equal ease. Incidentally, the Arosorb process rejects the bulk of any olefins present in the feed to the saturate product.

The saturate product is a light gasoline with an F-1 unleaded octane number of 62, but it also holds considerable

TABLE 1. Catalytic reformate—charge and product tests.

	Arosorber Charge	Benzene	Toluene	Saturate Product
Yield, per cent by volume	100.0	16.5	16.5	67.0
Chemical composition, per cent by volume:				
Aromatics	35	99	99	3
Olefins	2	...	...	3
Paraffins	56	...	...	84
Naphthenes	7	...	...	10
Specific gravity, 60/60 F	0.7580	0.8830	0.8707	0.6995
Solidifying point, deg C	...	5.10	...	...
Paraffins, per cent by volume	...	...	0.8	...
ASTM distillation:	D-86-46, deg F	D-850, deg C	D-850, deg C	D-86-46, deg F
Initial boiling point	156	79.4	110.0	150
50-per-cent point	186	80.0	110.7	185
Dry point	220	80.3	111.0	220
Acid-wash color	...	4*	6*	...
Bromine index	...	227*	...	...
Acidity	...	No free acid	No free acid	...
Sulfur compounds	...	Negative	Negative	...
Copper-strip corrosion	...	Negative	Negative	...
F-1 octane number, without TEL addition	75.7	...	...	62

* Before finishing.

TABLE 2. 200-F to 300-F catalytic gasoline fraction—charge and product tests.

	Arosober Charge	Aromatic Product	Saturate Product
Yield, per cent by volume	100.0	36.2	63.8
Chemical composition, per cent by volume:			
Aromatics	35	92	2
Olefins	6	1	8
Naphthenes	30	4	46
Paraffins	29	3	44
Gravity, deg API at 60 F	47.0	32.7	55.7
ASTM distillation, deg F:			
Initial boiling point	208	232	215
10-per-cent point	224	251	232
50-per-cent point	242	266	244
90-per-cent point	276	288	272
End point	320	364	304
Aniline point, deg F	67.1	...	128.3
Mixed aniline point, deg F	116.2	55.7	...
Kauri butanol solvent, ml at 77 F	55.4	90.0	36.9
Sulfur, per cent by weight	0.014	0.016	0.010
Octane No.:			
F-1, without TEL addition	83.9	...	63.1
F-1 plus 1 ml TEL per gal	...	...	74.0
Performance No.:			
F-3 plus 4.6 ml TEL per gal	...	109	...
F-4 plus 4.6 ml TEL per gal	...	195	...

TABLE 3. 300-F to 400-F naphtha fraction—charge and tests.

	Arosober Charge	Aromatic Product	Saturate Product
Yield, per cent by volume	100.0	15.8	84.2
Chemical composition, per cent by volume:			
Aromatics	17	91	1
Naphthenes	26	3	31
Paraffins	57	6	68
Gravity, deg API at 60 F	47.4	31.1	51.1
ASTM distillation, deg F:			
Initial boiling point	298	306	295
10-per-cent point	318	322	316
50-per-cent point	334	336	337
90-per-cent point	354	356	356
End point	400	400	406
Aniline point, deg F	127.0	...	150.4
Mixed aniline point, deg F	140.7	75.2	...
Kauri butanol solvent, ml at 77 F	38.3	88.6	32.4
Sulfur, per cent by weight	0.019	0.028	0.010
Flash point (Tagliabue closed-cup tester), deg F	102	104	103

TABLE 4. Kerosine—Charge and product tests.

	Arosober Charge	Aromatic Product	Saturate Product
Yield, per cent by volume	100.0	15.8	84.2
Chemical composition, per cent by weight:			
Aromatics	16	91	1
Naphthenes	23	2	27
Paraffins	61	7	72
Bromine No.	0.4	1.5	0.0
Gravity, deg API at 60 F	43.3	24.4	47.0
ASTM distillation, deg F:			
Initial boiling point	338	340	335
10-per-cent point	370	374	368
50-per-cent point	410	414	408
90-per-cent point	458	465	455
End point	508	510	486
Aniline point, deg F	143.4	...	164.7
Mixed aniline point, deg F	147.6	75.2	...
Kauri butanol solvent, ml at 77 F	36.1	98.2	28.2
Sulfur, per cent by weight	0.015	0.075	0.010
Flash point (Tagliabue closed-cup tester), deg F	125	126	124

TABLE 5. Catalytic gas oil—charge and product tests.

	Arosober Charge	Aromatic Product	Saturate Product
Yield, per cent by volume	100.0	35.4	64.6
Chemical composition, per cent by weight:			
Aromatics plus olefins	39	92	5
Naphthenes	17	3	26
Paraffins	44	5	69
Bromine No.	6.0	16.3	0.5
Gravity, deg API at 60 F	29.3	11.1	41.2
ASTM distillation, deg F:			
Initial boiling point	422	425	420
10-per-cent point	484	486	483
50-per-cent point	511	515	508
90-per-cent point	562	575	559
End point	604	625	604
Aniline point, deg F	131.8	...	181.8
Mixed aniline point, deg F	138.2	72.7	...
DDT solvency, per cent by weight	...	42	...
Diesel index	39	...	75
Cetane No.	40	...	68
Pour point, deg F	+5	−25	+20
Sulfur, per cent by weight	0.16	0.26	0.10
NPA color	1¾	4	1¼
Flash point (Pensky-Martens closed-cup tester), deg F	225	227	225
Saybolt Universal viscosity at 100 F, sec	36.4	36.2	36.5

TABLE 6. Operating costs for processing catalytic reformate.

Arosorber Unit	I		II		III	
Plant investment, millions of dollars	0.72		1.60		2.26	
Throughput, barrels per day	500		2,500		5,000	
Fixed charges, dollars per day:						
Depreciation, 10 years	197		438		619	
Insurance and taxes, 0.5 per cent	10		22		31	
Maintenance, 5 per cent	99	306	219	679	310	960
Direct charges, dollars per day:						
Labor	120		120		120	
Utilities: power	7		35		70	
fuel	17		84		168	
steam	8		37		74	
water	9		44		88	
Supplies: xylene	2		10		20	
silica gel	32		161		322	
activated alumina	3	198	12	503	24	886
Total operating cost		504		1,182		1,846
Dollars per barrel		1.01		0.47		0.37
Cents per gallon		2.35		1.12		0.88

TABLE 7. Operating costs for processing kerosine.

Arosorber Unit	I		II		III	
Plant investment, millions of dollars	0.72		1.6		2.26	
Throughput, barrels per day	820		4,100		8,200	
Fixed charges, dollars per day:						
Depreciation, 10 years	197		438		619	
Insurance and taxes, 0.5 per cent	10		22		31	
Maintenance, 5 per cent	99	306	219	679	310	960
Direct charges, dollars per day:						
Labor	120		120		120	
Utilities: power	7		35		70	
fuel	18		88		176	
steam	8		41		82	
water	9		44		88	
Supplies: isopentane	3		15		30	
toluene	2		12		24	
silica gel	32		161		322	
activated alumina	3	202	12	528	24	936
Total operating cost		508		1,207		1,896
Dollars per barrel		0.62		0.29		0.23
Cents per gallon		1.48		0.69		0.55

TABLE 8. Operating costs for processing catalytic gas oil.

Arosorber Unit	I		II		III	
Plant investment, millions of dollars	0.72		1.60		2.26	
Throughput, barrels per day	360		1,800		3,600	
Fixed charges, dollars per day:						
Depreciation, 10 years	197		438		619	
Insurance and taxes, 0.5 per cent	10		22		31	
Maintenance, 5 per cent	99	306	219	679	310	960
Direct charges, dollars per day:						
Labor	120		120		120	
Utilities: power	7		35		70	
fuel	15		75		150	
steam	9		45		90	
water	8		38		76	
Supplies: isopentane	5		24		48	
toluene	10		50		100	
silica gel	32		161		322	
activated alumina	3	206	12	560	24	1,000
Total operating costs		512		1,239		1,960
Dollars per barrel		1.42		0.69		0.54
Cents per gallon		3.38		1.64		1.29

promise as a very light paraffinic solvent.

Catalytic Gasoline. Table 2 gives similar information for processing a 200-F to 300-F catalytic gasoline fraction. The aromatic product containing 92 per cent aromatics commands interest as a medium-drying aromatic solvent because of the 90 Kauri butanol solvency. This material also has an F-4 performance number of 195, upon the addition of 4.6 ml TEL per gal and, therefore, is a valuable rich-mixture aviation-gasoline blending agent. The saturate product is considerably degraded in octane number from the charge because of the removal of aromatics, but still has an F-1 rating of 74 upon the addition of 1 ml TEL per gal.

300-F to 400-F Naphtha. Table 3 gives results from the treating of a 300 to 400-F straight-run naphtha fraction. The 88 Kauri butanol solvency of the aromatic product makes it an excellent high-solvency medium-drying solvent. The saturate product containing no olefins and only 1 per cent of aromatics is of considerable interest as a stock very closely approaching an odorless solvent of the medium to slow-drying type.

Kerosine. Table 4 gives the results of processing a typical kerosine; and the products are similar to those just discussed, except for the boiling point which throws them into the slow-drying solvent type.

Catalytic Gas Oil. Table 5 covers the operation on a typical catalytic gas oil, the highest-boiling product for which data are presented. Still higher boiling products can be handled under somewhat different conditions.

The aromatic product from catalytic gas oil may be used as a very slow-drying solvent or as an insecticide solvent. The saturate product with a 68 cetane number has application as a high-cetane diesel-fuel blending agent. One part of this material will blend with two or more parts of typical catalytic gas oil to give a 50-cetane fuel.

Desulfurization. As shown in Tables 2 to 5, sulfur compounds tend to concentrate in the aromatic product, giving saturates with sulfur contents much lower than those of the corresponding charge stocks. This point is of small importance with the low-sulfur materials used in this work, but may have real significance to the refiner who runs high-sulfur crudes.

Investment and Operating Costs

How the process operates, and what it can do for the refiner, have been developed. Now for the cost picture.

Estimated investment and operating costs for three different sizes of Arosorb units, designated I, II, and III, are presented in the following text and in Tables 6 through 9. The operating costs for these three units are also shown for three typical operations, viz., charging catalytic reformate, kerosine, and catalytic gas oil.

The 3 units were designated basically for charging 500, and 2500, and 5000 bbl per day of catalytic reformate for the production of benzene and toluene. The throughputs were then calculated for the kerosine and catalytic gas-oil operations after the removal of only obvious, small bottlenecks. As a result, the investment costs represent completely flexible plants with the indicated capacities for the several typical operations. The estimated plant investment ranges from $720,000 for the 500-bbl-per-day charging capacity to $2,260,000 for the 5000-bbl-per-day unit. These investment figures are based on an erected plant within battery limits, including silica gel and activated alumina, as well as engineering and contractor's fees.

The units have a greater capacity for kerosine than catalytic reformate which results from the low aromatic content of the kerosine, and a comparatively low distillation load per barrel of charge. The high viscosity of the catalytic gas oil requires greater dilution and this, together with the higher aromatic content, reduces throughput.

Table 6 gives the operating costs for the 3 units processing the catalytic reformate stock. The operating costs — which include the fixed charges for 10-year depreciation, insurance, taxes, and maintenance—range from 2.3 cents per gallon of charge for the smallest plant to 0.9 for the largest plant. The unit costs for labor and utilities were based on approximate Gulf Coast figures, and the values used are given in Table 9 so as to permit converting processing costs to any other basis desired.

Table 7 covers similar information for charging kerosine. As indicated previously, the capacity of the units is appreciably increased, viz., about 60 per cent higher than for reformate; and, as a result, operating costs per gallon of charge are down to 1.5 to 0.6 cents, depending again on the size of the unit.

As shown in Table 8, the range of throughput for the catalytic gas-oil operation is 360 to 3600 bbl per day. The operating cost range is 3.4 to 1.3 cents per gallon of charge.

New Synthetic Chemical Promises Soil Improvement

Tests have indicated that a new synthetic chemical, derived from natural gas, increases the productivity of poor soil in hours instead of years required by present methods. The chemical which has acrylonitrile as its starting material, is neither a fertilizer nor a plant food, but rather a soil conditioner. When it is mixed with moist soil, it dissolves immediately and splices the tiny soil particles together to form larger crumbs or aggregates. As a result of this change of consistency, plants can obtain optimum amounts of oxygen, water and nutrients from the soil, and crop yields increase. The new chemical is not yet in commercial production, but is expected to be within a short time.

TABLE 9. Labor and utility costs, based on Gulf Coast.

Labor	2 men per shift at $2.00 per hour
Supervision	1 man for 1 shift per day at $3.00 per hour
Power	$0.005 per kilowatt-hour
Fuel	$0.12 per million Btu's (as gas)
Steam	$0.25 per 1,000 lb
Water	$0.02 per 1,000 gal

A running royalty figure was not included in the foregoing operating costs, as it is a small item. A basis for a paid-up royalty is provided for those refiners who prefer such an arrangement.

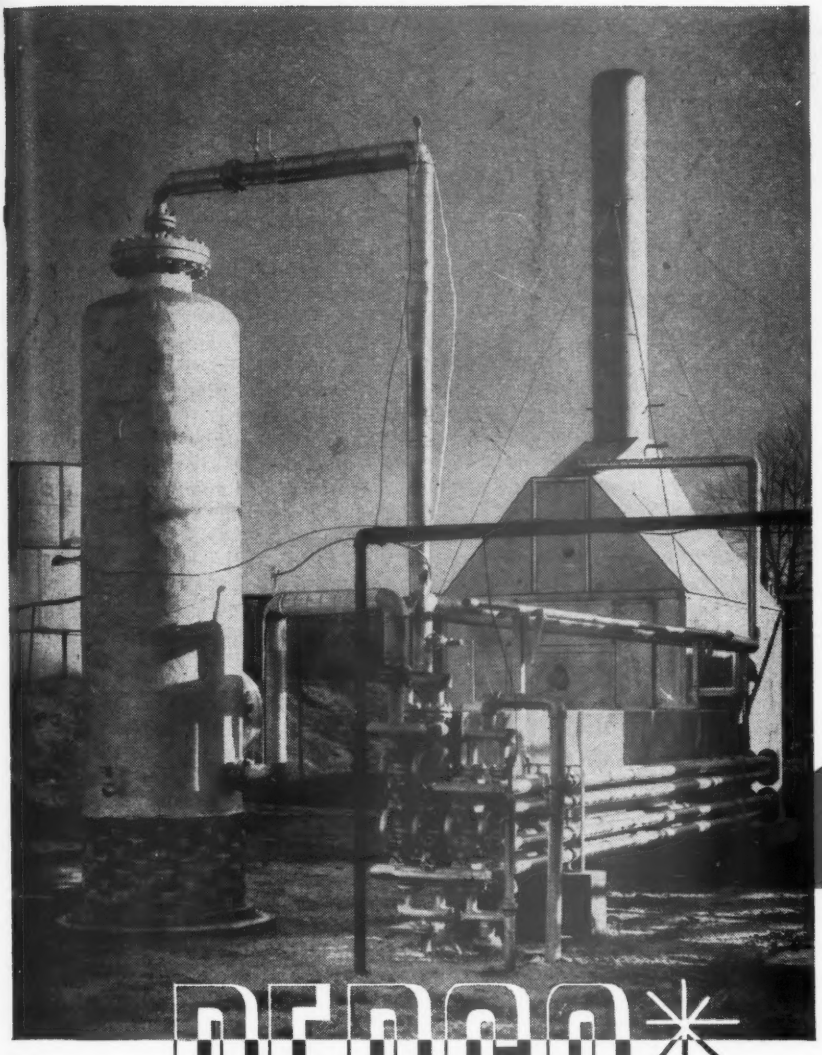
Diversified Operations

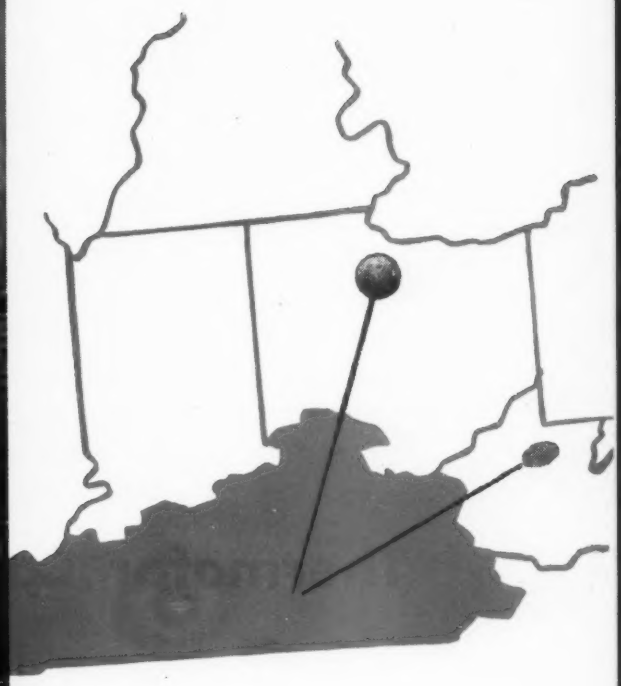
Particularly in the case of the larger Arosorb units, operating continuously on either kerosine or catalytic gas oil might produce too large a quantity of products compared to demand. Furthermore, many refiners would wish to process a variety of stocks in order to have a diversified line of aromatic and saturate solvents, diesel oil, etc. Advantage may then be taken of the great flexibility of the Arosorb process, which permits the refiner to select the best combination of operations to suit the market situation at any particular time. Inasmuch as Arosorbers of the type described in this paper can handle almost any type of available refinery stream (from 150 to 700 F), the number of operating combinations and the diversity of products are virtually unlimited. The problem then becomes only one of selecting the most profitable combination.

Fig. 4 was prepared merely as an example to illustrate diversification, using the 3 charge stocks for which operating cost figures were given earlier. In Fig. 4 the number of days per month for each of the 3 operations is given at the bottom, and the amount of each product produced is shown by the vertical bars. The chart was calculated for Arosorber II, the intermediate-size unit.

The situations developed by running kerosine and catalytic gas oil each for 2.5 or 5 days per month at the expense of catalytic reformate result in an interesting balance of products, ranging from benzene and the fastest drying aromatic and saturate solvents to the slowest drying solvents and diesel fuel. The saturate gasoline produced incidental to the manufacture of benzene and toluene was not included in Fig. 4 because gasoline quantities are not normally considered in terms of gallons per year. Expressed as barrels per month, the gasoline amounts to 51,000, 42,000, and 34,000, respectively, for 3 cases.

Of necessity, the studies outlined herein have been limited to three stocks. Many refiners may have other streams, however, varying in boiling range and aromatic content, which they might wish to process. Specific proposals to suit the individual refiner's needs can readily be prepared, and such additional information should be obtained from Universal Oil Products Company or Houdry Process Corporation, both of which are agents authorized to license the Arosorb process under patent rights of the Sun Oil Company. * * *





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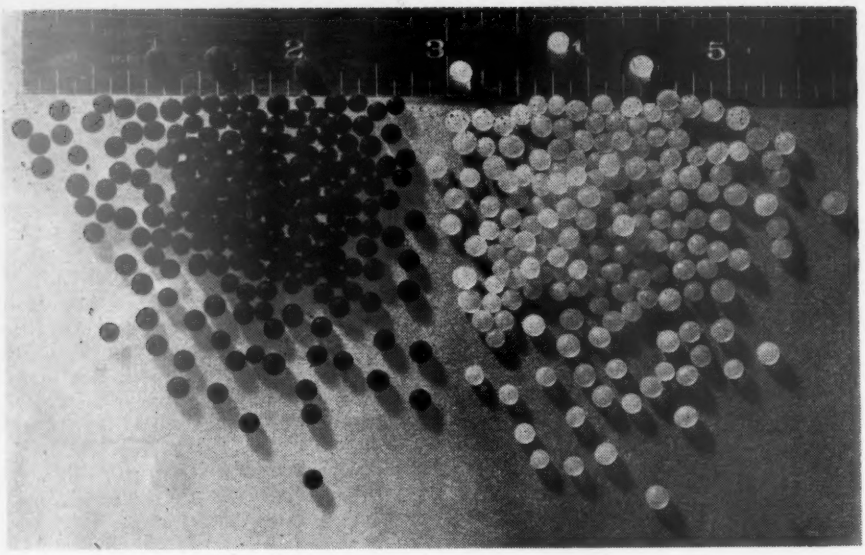

FIG. 1. Chromia-alumina bead reforming catalyst, left, compared with TCC bead cracking catalyst, right.

Thermofor Catalytic Reforming (TCR)†

Upgrading stocks possible at reasonable cost — premium fuels of high anti-knock quality are produced with this process

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E. V. BERGSTROM,[2] V. O. BOWLES[2]

This paper describes the development of the Thermofor catalytic reforming (TCR) process which provides the refiner with a modern, economical method of up-grading his low octane-number straight-run and thermal gasoline stocks into premium fuels in the F-1 octane-number range of 100. Almost complete sulfur removal is effected simultaneously, chiefly as hydrogen sulfide in the "make" gas. Butane yields are low, thus permitting the use of considerable outside butanes to meet vapor-pressure requirements. The process has been proved through almost 3 years of intensive pilot-plant study with the use of a 50-bbl-per-day unit, and the process has been engineered for commercial applications ranging up to a capacity of 20,000 bbl per day.

The catalyst used is chromia-alumina gel in a rugged bead form, and this catalyst was the subject of a separate development program. The process is of the regenerative moving-bed type which employs a single pressure reactor, with no reheat furnaces, and an atmospheric TCC-type kiln. Catalyst circulates at a low rate through the system, and is regenerated continuously. This affords wide flexibility not only in the handling of motor-gasoline stocks, but also for the processing of narrower cuts into highly aromatic aviation blending stocks. Four commercial TCR units, with a total capacity of about 50,000 bbl per day, and a catalyst manufacturing plant are planned for installation in the immediate future.

†Presented to a Session on Production of Aromatics during the 12th Mid-Year Meeting of American Petroleum Institute's Division of Refining, St. Francis Hotel, San Francisco, California, May 14, 1952.

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Introduction

PART of the progress made in automotive-engine design during recent years has been founded on the ability of the petroleum industry to produce gasolines of progressively higher anti-knock quality level. Except during World War II octane numbers have increased steadily over a considerable period of time, at the rate of 1 to 1½ units per year, to the current average level of about 84 F-1 octane number for regular-grade and about 91 F-1 for premium-grade gasolines. The demand for still higher octane numbers seems destined to continue, with increased emphasis being placed on high-compression engine design. If the trend continues to the 12:1 compression-ratio level, the octane-number requirement may be in the F-1 range of 98 to 100.

This poses an important challenge for the petroleum refining industry: It means that more drastic and efficient processing techniques must be adopted to attain these high anti-knock quality levels. Present octane-number levels are being met largely by catalytic cracking, supplemented by thermal reforming and cracking, and by catalytic polymerization.

The relative quantity and quality of gasoline components supplied by these operations at present are approximately as shown at bottom of this column.

Although some minor increase in present octane-number levels could be effected by more extensive use of catalytic cracking and catalytic polymerization, there are obvious limitations to this course. The most effective method of attaining the substantial increase required would be to upgrade the low octane-number components of straight-run and cracked gasolines. This requires a more selective process than the widely used thermal reforming process, which gives excessive yields of gas and tar when high octane-number levels are attained by reforming. The answer to the problem is catalytic reforming.

In anticipation of this trend, Socony-Vacuum has for several years been carrying on experimental work that has culminated in the development of the Thermofor catalytic reforming (TCR) process. This work involved both catalyst research and process development —first through various types of bench-scale studies and, finally, on a 50-bbl-per-day pilot-plant scale. The entire development program was conducted at Socony-Vacuum's research and development laboratories, in Paulsboro, New Jersey.

The TCR process employs a synthetic chromia-alumina bead catalyst which

	Per Cent	F-1 Octane Number (With Addition of 3 Ml TEL Per Gal)
Catalytic gasoline	31	98
Thermal gasolines	26	89
Straight-run naphtha (including natural)	33	84
Heavy straight-run naphtha	8	68
Catalytic polymer gasoline	2	115
	100	89 pool octane no[s]

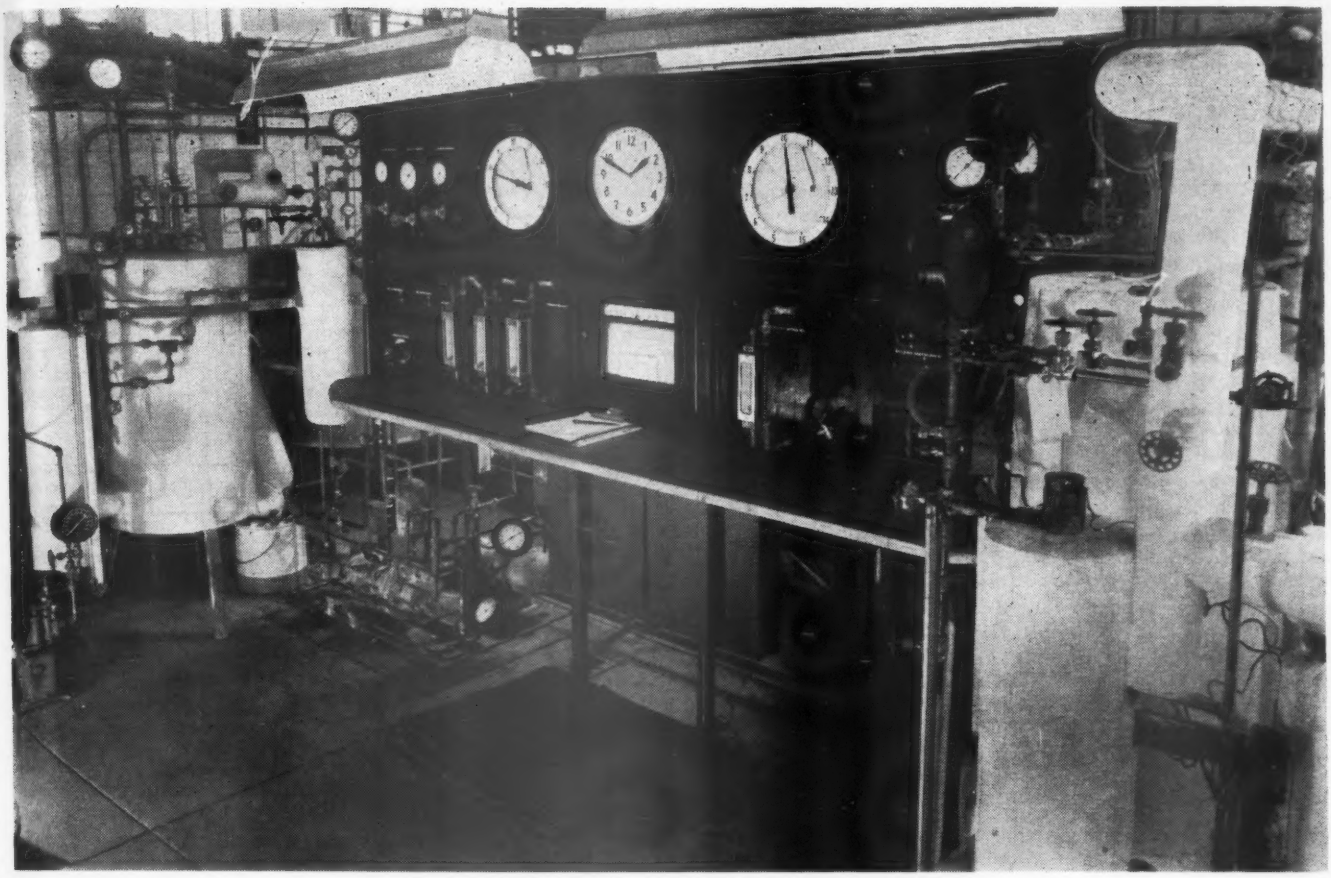


FIG. 2. Bench scale isothermal units (700 cc) used in evaluating catalysts and stocks for TCR reforming. Twin units at opposite ends of common panel board.

circulates through a moving-bed system comprising a reactor and a kiln; thus provision is made for continuous reaction, with regeneration of the catalyst. As implied by the term "Thermofor," the design of this system embodies many of the principles applied successfully in the well-known TCC (Thermofor catalytic cracking) process over the past 10 years.[1,2a]

Preliminary announcements of the TCR process were made last year at the Third World Petroleum Congress,[3] and recently in the press. It is the purpose of this paper to review briefly the development work which led to the process, including performance data on various stocks, and to describe in more detail the process design for commercial installation.

Development Program

Catalyst. Various types of catalyst are known to be selective for the reforming of petroleum naphthas. Of these, the one finally selected for development specifically for the TCR process is a synthetic chromia-alumina gel. This type of catalyst has many desirable characteristics:

1. It has a "high octane-number ceiling"; i.e., it permits reforming to high anti-knock quality (F-1 100 octane number, or higher, upon the addition of 3 ml TEL per gal) with good yields.
2. It operates with low hydrogen partial pressure.
3. It can be readily regenerated. This can be accomplished by burning off the coke deposits. Thus wide latitude is provided for the reforming of all types of stocks, particularly the high coke-forming thermally-cracked stocks, as well as broad boiling-range straight-run stocks.
4. It promotes excellent desulfurization, and the sulfur is eliminated mainly as hydrogen sulfide in the reforming gas — thus avoiding a potential air-pollution problem.
5. Finally, the catalyst is in bead form, and it possesses the high physical strength and ruggedness of the widely used TCC bead cracking catalyst (Fig. 1).

A more detailed discussion of these and other characteristics of the chromia-alumina gel reforming catalyst is given in a recent paper by Hughes et al.[4]

This catalyst has regeneration characteristics of marked significance in commercial application; e.g., it can be regenerated at a much lower temperature than cracking catalyst. All of the coke burns to carbon dioxide. The catalyst does not exhibit any significant oxidation-reduction phenomena. No appreciable amounts of sulfur dioxide are discharged with the flue gas for the reason that the sulfur is largely eliminated in the reactor rather than in the regenerator.

Bench-Scale Studies. The next important development step involved investigation of the catalyst in bench-scale units so as to obtain accurate yield-octane-number data on representative types of stocks under a wide variety of processing conditions. These data provided a basis for determining whether the process was economically attractive for further development.

Two types of bench-scale units were employed in this work. One was an isothermal fixed-bed unit with a 700-ml reactor immersed in a lead bath (Fig. 2). Initially this unit was operated with hydrogen addition from cylinders. Subsequently it was modified to include a gas-recycle pump so that actual recycling of hydrogen-rich process gas could be studied. The second unit was similar to the first, except that its reactor had a catalyst capacity of 2000 ml, and it was designed to operate essentially adiabatically—thus making possible a study of heat effects during reaction and regeneration under various types of operating conditions.

The major process variables covered in this bench-scale study were pressure, gas-recycle ratio, reaction temperature, space velocity, and catalyst-to-naphtha ratio. The effect of these variables is discussed hereinafter:

a. Pressure: Reaction pressures covered a range from atmospheric to 500 psig. When reforming proceeds to a given octane number, lower pressures result in a more satisfactory yield of 10

[a]Figures refer to References at end of article.

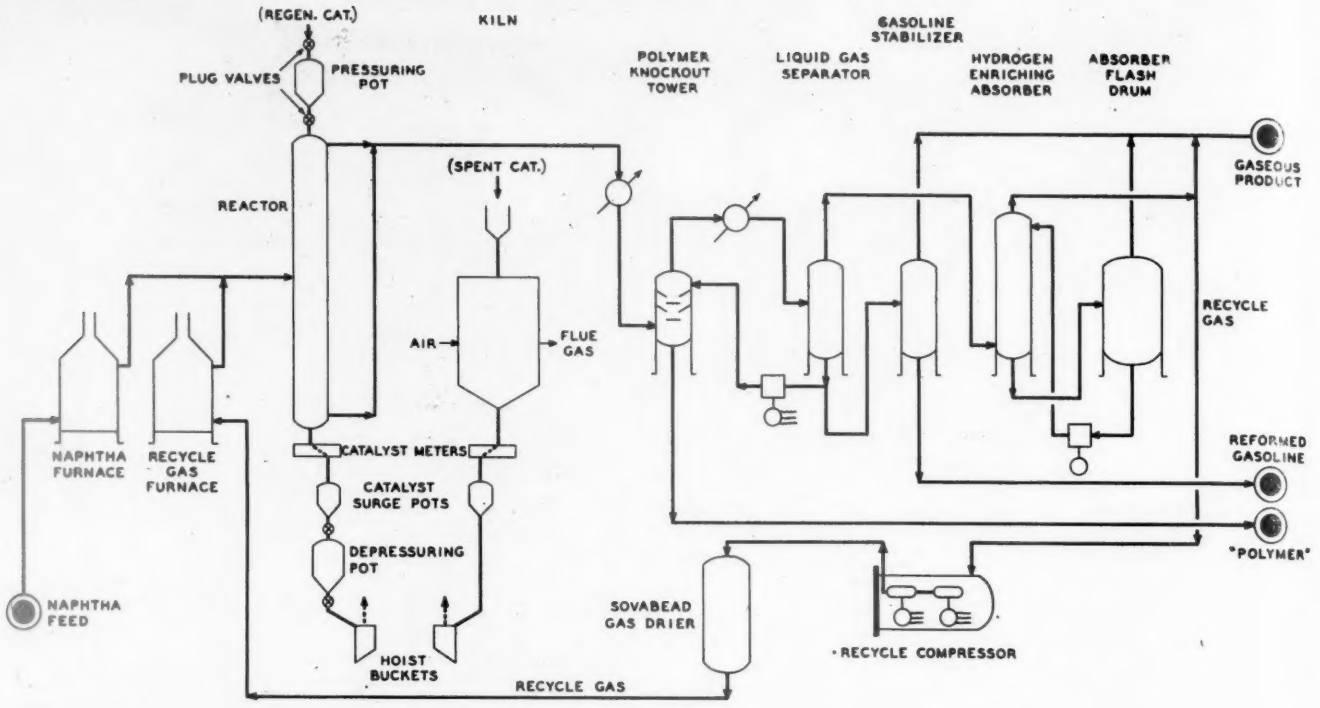


FIG. 3. Flow diagram of a 50-bbl per day TCR pilot plant.

lb Reid vapor pressure gasoline and a higher hydrogen and coke production. Bench-scale data indicate the desirable pressure range to be between 100 and 200 psig—the level within that range depending on the stock and depth of reforming.

b. Gas-recycle ratio: Gas-recycle ratios up to 12 mols of gas per mol of naphtha have been explored. As the recycle ratio is increased, coke "make" decreases appreciably and gasoline yield increases slightly, whereas the hydrogen content of the recycle gas remains fairly constant. In adiabatic operation gas recycle also aids in supplying reaction heat. Practical recycle ratios appear to be in the range of three to nine.

c. Temperature: After other process conditions are fixed, reactor temperature is the principal variable for controlling the reforming severity and octane number of the product. The temperature severity required depends on the stock, and it can range from about 950 F on an easily reformed stock to 1000 F for a refractive-type stock for reforming to an F-1 octane-number level of 100 upon the addition of 3 ml TEL per gal.

d. Space velocity: As a means of controlling severity, space velocity is interchangeable with temperature over a fairly wide range; i.e., lower temperatures can be used with lower space velocities in order to produce the same yield-octane-number result. A space velocity of about 0.7 volume of naphtha per unit reactor volume per hour is satisfactory for the temperature range indicated previously.

e. Catalyst-to-naphtha ratio: Catalyst-to-naphtha ratio can be varied over a wide range, with no marked effect on product yields and quality, provided coke concentration on the catalyst does not become excessive. Because coke deposition with this catalyst is relatively low, it is possible to operate with very low catalyst-circulation rates compared to those used in catalytic cracking.

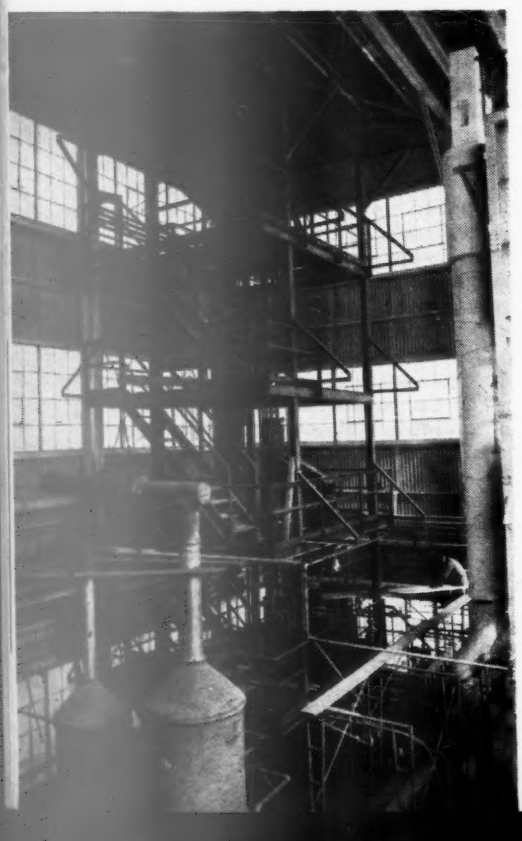


FIG. 4. View of TCR pilot plant during construction. Furnaces in foreground; reactor within structure between second and fourth platforms, with small rectangular kiln and blower at right above second platform. Panel board and product recovery system in lower background.

f. Yield-octane-number relationship for various stocks: A summary of representative yield-octane-number data obtained on various stocks in this bench-scale program was included in the paper by Hughes et al.[4] It was shown that the yield-octane-number relationship of the various naphthas correlates well with the conventional characterization factor *K*.

50-Bbl-Per-Day Pilot Plant

In view of the promising results obtained in the catalyst development and bench-scale investigations, extensive engineering and economic studies were made for the purpose of appraising the commercial potentialities of the process. These studies led to the third and final phase of the development program, viz., the construction and operation of a 50-bbl-per-day moving-bed pilot plant. This unit was erected almost three years ago in order to prove the important operating features of the process, and in order to provide information for the design of commercial units. The following is a brief description of the 50-bbl-per-day program:

Equipment. The reactor is a stainless-steel vessel, with an inside diameter of 12 in.; it is 15 ft high, and is designed to operate at pressures up to 500 psig. It is mounted inside of a 24-in. diameter carbon-steel jacket. The 6-in. annular space between the 2 shells is filled with insulation so as to make the reactor essentially adiabatic. Vapor inlet and outlet manifolds are arranged so that the reactor can be operated with downward, upward, or split flow of the vapor stream. For catalyst flow, pressure pots and plug valves are provided above and below the reactor.

The kiln is an atmospheric vessel designed to simulate multi-zone regeneration of the catalyst. A skip-hoist system is provided for transfer of the catalyst

between reactor and kiln. The entire structure around the reactor and kiln is about 55 ft high.

Two gas-fired furnaces are used for separate preheating of the naphtha and recycle-gas streams. The two preheated streams are mixed just before they enter the reactor.

The product-recovery system is designed to permit study of various possible processing schemes. Equipment includes a knockout pot in which the reaction vapors are quenched so as to condense a heavy polymer cut, a water cooler and gas separator, an absorption system for the study of hydrogen enrichment, and a product-stabilizer tower.

A flow diagram of the 50-bbl-per-day unit is shown in Fig. 3. Fig. 4 is a photograph of the unit taken during the latter stages of construction.

Stock Evaluations. Ten different types of stocks have been processed in the 50-bbl-per-day pilot plant. One of these stocks, viz., a 200- to 380-F-end-point straight-run naphtha from Tibu-Petrolea (Colombia) crude, was available in large quantity at Socony-Vacuum's Paulsboro, New Jersey, refinery; therefore, it was used for "shakedown" operations and for extensive study of process variables. The other stocks, obtained from several other refineries in tank-car quantities, represent potential charge stocks for TCR units being considered at those plants. These stocks included both straight-run naphthas and blends thereof with thermal gasolines—these stocks boiling chiefly in the 200 to 400 F range. One stock, which comprises approximately equal parts of straight-run and high-sulfur coker naphthas from Wilmington, California, crude, required reforming for sulfur removal as well as for octane-number improvement. All stocks were selected from normal refinery operations, and no special precautions were used to obtain clean fractionation.

Table 1 summarizes the properties of 5 of these stocks, and Table 2 gives actual pilot-plant data for reforming them under commercial design conditions to octane-number levels in the F-1 range of 96 to 100 upon the addition of 3 ml TEL per gallon. It will be noted, in the case of the Wilmington blend, that excellent desulfurization and anti-knock quality improvement are obtained, with a high product yield.

Because of the large scale of the pilot-plant operation, it was obviously possible to prepare adequate quantities of products for extensive performance tests. As shown in Table 2, the pilot-plant gasolines have a moderate olefin content, and they require only a small amount of inhibitor—up to 3 lb per 1000 bbl—for acceptable stability. Hughes et al[4] have already reported results of engine tests which show that finished TCR gasolines have an acceptable engine-cleanliness rating, and that they give road anti-knock performance consistent with laboratory ratings of other gasolines in the same range.

The characteristics of the products obtained from the operation of the 50-bbl-per-day pilot plant were essentially the same as those obtained from bench-scale operations. Also, the study of process variables in the 50-bbl-per-day unit confirmed the pattern established in the bench-scale units.

Water Elimination. It was found, in the course of the pilot-plant program, that the presence of moisture in substantial concentration in the reaction zone has an adverse effect on product yields. In order to avoid excessive moisture in this part of the system, provision was made for drying the recycle-gas stream. Adsorbed moisture or oxygen on the regenerated catalyst is automatically removed before it enters the reaction zone in the split-flow reactor arrangement.

Catalyst Valves. As noted previously, a pressure-lock system is used to introduce regenerated catalyst into the reactor. Operating experience in the 50-bbl-per-day unit—supplemented by extensive valve-wear studies under commercial design conditions through 15,000 operating cycles—has shown that lubricated plug valves with stellited surfaces perform satisfactorily. Such valves give excellent tight service for many months, with negligible wear or scoring of the seats and plugs.

Catalyst Life. One important objective of the 50-bbl-per-day pilot-plant program was to study catalyst-life characteristics. This refers to the ability of the catalyst to sustain activity and selectivity, as well as physical strength, in prolonged TCR service.

Bench-scale aging tests had indicated that the catalyst activity decreased only to the extent of a 3-per-cent drop in gasoline yield in equilibrating through repeated reforming-regeneration cycles. This has been confirmed in the 50-bbl-per-day pilot plant, wherein one batch of catalyst has been in service for about 18 months. Despite the extreme types of operation to which this catalyst has been subjected in that period, it activity loss has been equivalent to as little as 2 per cent lower gasoline yield than fresh catalyst at the F-1 octane-number level of 98 upon the addition of 3 ml TEL per gal. In this connection, the yields shown in Table 2 were obtained on an aged catalyst.

With regard to physical stability, no particular problem is anticipated with this catalyst in commercial operation.

Hydrogen Enrichment. Operations with hydrogen enrichment of the recycle gas showed no measurable advantage.

TABLE 1. Properties of charge stocks used in 50-bbl-per-day TCR reforming runs in Table 2.

	Tibu-Petrolea (Colombia) Paraffinic Naphtha	Mixed Texas Naphthas	Depentanized West Texas Naphtha	California (Wilmington) Naphtha	Blend of 54 Per Cent Straight-run Naphtha and 46 Per Cent Coker Naphtha from Wilmington Crude
Gravity, deg API	54.6	56.8	57.6	45.9	46.3
Norwood bromine No.	0.9	3.0	1.7	1.0	36.7
Olefins, per cent by volume	0.7	2.2	1.1	0.8	30.3
Aromatics, per cent by volume	11.3	8.8	15.9	16.0	14.7
Sulfur, per cent by weight	0.032	0.084	0.17	0.15	0.59
F-1 Octane Numbers:					
Without TEL addition	33.0	50.8	61.2	55.0	65.2
With addition of 3 ml TEL per gal	60.6	68.4	75.2	71.5	75.4
ASTM Distillation, in deg F:					
Initial boiling point	177	128	166	166	225
10-per-cent point	265	198	189	264	266
50-per-cent point	298	268	212	338	314
90-per-cent point	337	338	257	380	368
End point	380	384	295	401	400

TABLE 2. Typical yields on TCR reforming of various stocks in 50-bbl-per-day pilot plant.

Charge Stock	Tibu-Petrolea Naphtha	Mixed Texas Naphthas	West Texas Naphtha	California Straight-run Naphtha	California Straight-run and Coker Blend
Reforming Conditions:					
Pressure, psig	175	175	175	175	175
Space velocity, volumes of naphtha per hour per volume of catalyst in the reactor	0.88	0.72	0.70	0.50	0.80
Average reactor temperature, deg F	986	982	969	985	955
Recycle gas to naphtha, mol ratio	6.0	9.4	6.4	9.0	5.9
Hydrogen in recycle gas, mol per cent	50	60	67	49	50
Recycle-gas furnace outlet, deg F	1,090	1,070	1,070	1,050	987
Naphtha-furnace outlet, deg F	1,030	1,019	1,013	1,050	987
Yields Based on Charge:					
10-lb-RVP reformate, per cent by volume	82.0	87.2	96.1	85.4	94.0
Outside C_4 required, per cent by volume	—1.0	0.6	6.4	2.7	6.1
C_5+ reformate, per cent by volume	83.0	86.6	89.7	82.7	87.9
Total C_3, per cent by volume	8.6	7.9	4.6	4.8	3.6
Total C_4, per cent by volume	8.4	7.5	3.9	6.5	4.7
C_3 and lighter, per cent by weight	16.1	12.1	8.6	14.5	10.0
Coke, per cent by weight	0.7	0.3	0.2	1.5	1.4
H_2 production, cubic feet per barrel	376	414	365	430	247
Properties of C_4+ Reformate:					
Gravity, deg API	53.2	55.4	55.4	44.4	46.6
Norwood bromine No.	9.5	9.8	8.2	17.4	13.5
Aromatics, per cent by volume	44.0	34.6	35.6	45.5	33.1
Sulfur, per cent by weight	0.007	...	0.010	0.013	0.015
F-1 Octane Numbers on 10-lb-RVP Reformate:					
Without TEL addition	91.1	87.0	85.4	94.9	89.3
With addition of 3 ml TEL per gal	99.1	97.1	96.5	101.4	97.9

TABLE 3. TCR reforming for aviation-gasoline blending.

Charge Stock	West Texas Straight-run Naphtha	California Straight-run Naphtha
Gravity, deg API	54.1	54.7
Boiling range, deg F	212 to 299	202 to 312
F-1 octane number, unleaded	60	68
Reforming Conditions:		
Pressure, psig	175	175
Space velocity, volumes of naphtha per hour per volume of catalyst in the reactor	0.35	0.35
Average reactor temperature, deg F	973	1,023
Gas-recycle ratio	12	12
Yields:		
Pre-aviation cut (C_4 to 200-F-end-point), per cent by volume	35.2	29.7
Aviation-blend stock (200 to 300 F), per cent by volume	42.3	32.4
Post-aviation cut (300-F-end-point plus), per cent by volume	5.0	6.6
C_3 and lighter, per cent by weight	15.0	24.9
Coke, per cent by weight	0.4	2.0
7-lb-RVP Aviation Stock:*		
Yield, per cent by volume of charge	63.0	48.4
Aviation-blending octane number (F-3) with addition of 4.6 ml TEL per gal.	99.5	98
Supercharge index number (F-4) with addition of 4.6 ml TEL per gal.	160	177

* Pressured with isopentane.

Consequently it is not planned to provide for hydrogen enrichment in the commercial design.

Polymer Removal. On most reformed stocks it is necessary to provide for the removal of about 1 per cent polymer in order to insure a satisfactory gum test on the motor-gasoline product. This can be accomplished either in a separate rerun tower, into which the stabilizer bottoms are flashed, or by the employment of a "knock-out" pot in which a polymer cut can be taken ahead of the primary condenser. The knockout-pot system was tested successfully in the 50-bbl-per-day unit. The polymer consists almost entirely of aromatics which boil in the range of 400 to 700 F.

Reforming for Aviation - Gasoline Base-Stock Production. Although the foregoing summary deals entirely with reforming for motor-gasoline production, the process is, of course, equally adaptable for the production of highly aromatic aviation-gasoline base stocks. The preferred charge stocks for such operation are the straight-run gasoline fractions which boil in the 200 to 300 F range, particularly those which contain substantial amounts of naphthenes from which light aromatics are formed. Naphthenic crudes are obviously a better source of such naphthas than paraffinic crudes.

The reforming conditions required for the processing of such stocks for aviation gasoline are somewhat more severe than those necessary for motor-gasoline operation. In a unit designed for motor-gasoline reforming the added severity can be obtained by operation at the maximum temperature and at a somewhat reduced throughput rate—all other conditions remaining constant.

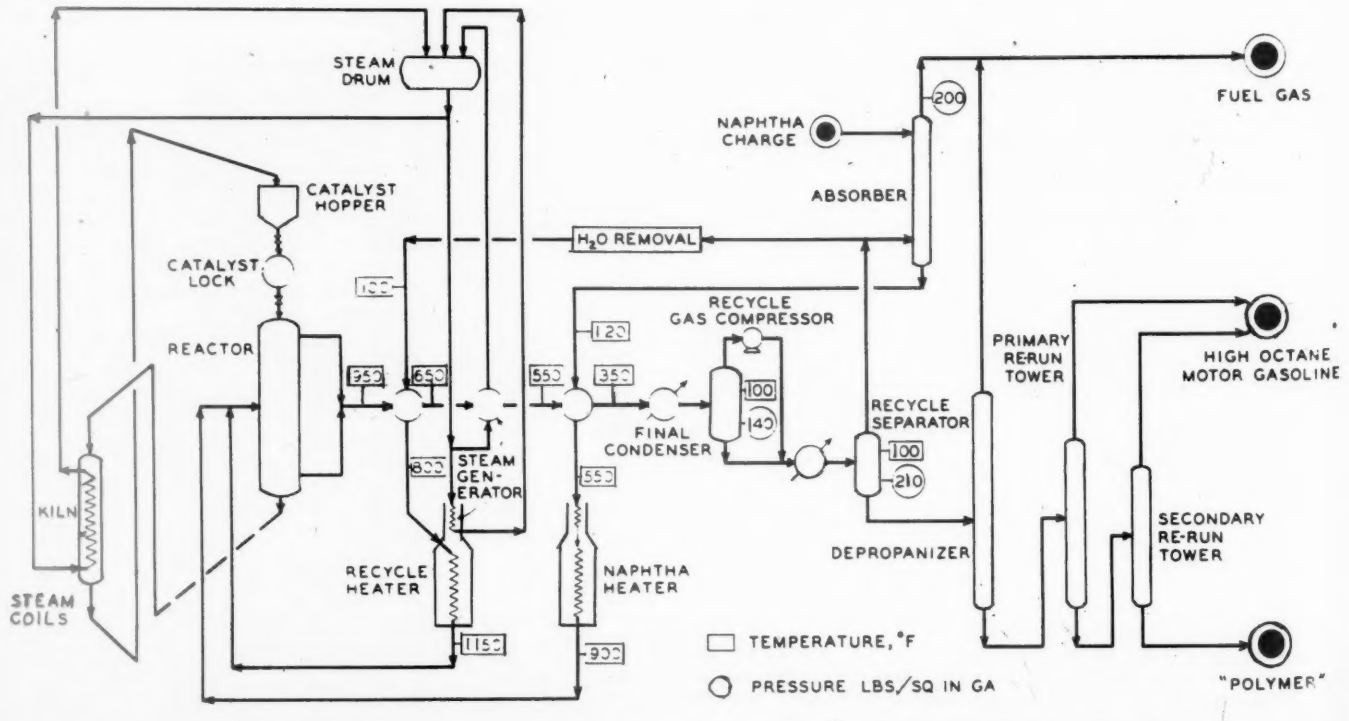
Several reforming runs of this type have been made on representative stocks in the 50-bbl-per-day unit. Data on West Texas and Wilmington naphthas are shown in Table 3. The West Texas naphtha yielded 42 per cent by volume of an aviation blending stock which, when pressured with *iso*pentane to a Reid vapor pressure of 7 lb, had an F-3 blending octane number of 99.5 and an F-4 index number of 160 upon the addition of 4.6 ml TEL per gal. The California naphtha yielded 32 per cent of aviation base stock which, with 4.6 ml TEL per gal, had an F-3 blending octane number of 98 and an F-4 index number of 177. Aviation reforming operations can be used equally well to produce reformates rich in specific aromatics such as benzene, toluene or xylenes.

Process and Mechanical Design of Commercial Units

Operating Conditions. Extensive process design and economic studies based on the pilot-plant program demonstrated that the optimum operating conditions are largely independent of feedstock properties. The final result of these studies led to the selection of a single reactor, without reheat, which employs gas recycle in the amount of approximately 6 mols of recycle gas per mol of naphtha, with operation at a pressure of about 175 psig and at a space velocity of 0.7. Average reactor temperature may range up to 1000 F for reforming to an F-1 octane number of 100 upon the addition of 3 ml TEL per gal.

Flow Plan. A schematic flow diagram for a commercial TCR unit is illustrated in Fig. 5. Starting with the reactor, the effluent therefrom flows through heat exchange, with recycle gas and naphtha, to a final condenser. The condensate and gas are then separated in a receiver which operates approximately at a pressure of 140 psig and a temperature of 100 F. The gas from this receiver is

FIG. 5. Socony-Vacuum Oil Company Thermofor catalytic reforming process—Diagrammatic flowsheet.



compressed to approximately 210 psig by the recycle-gas compressor. The condensate is pumped up to the same pressure, after which both are recontacted and cooled before they flow to the recycle separator. The condensate from the recycle separator is pumped to a depropanizer or to other suitable stabilization facilities.

The net gas production flows to an absorber, and thence to the fuel line. Naphtha charge is pumped over the absorber, in order to obtain the desired recovery of light hydrocarbons from this gas; and it is pumped from the base of this absorber through heat exchange, thence through the naphtha heater which raises the temperature to approximately 900 F, and finally into the reactor. The recycle gas, which is the main stream to leave the recycle separator, passes first through a dryer, next through heat exchange with the reactor effluent, and finally through the recycle heater which heats this material to a temperature of approximately 1150 to 1200 F. The hot recycle gas mixes with the heated naphtha just before both enter the reactor.

Catalyst flows downward through the reactor in a compact moving bed. Inasmuch as the catalyst flow is comparatively small, ranging from approximately 5 to 50 tons per hour for units which have throughputs up to 20,000 bbl per stream day, it may be transported from the base of the reactor to the top of the regenerator with bucket elevators or with other suitable lift equipment. The regenerator is a conventional multi-zone type of Thermofor kiln, similar in operating principle to those installed on TCC units.[1,2,5] This type of kiln is well-suited to the low catalyst-circulation requirements of the TCR process, and it does not embody any new or unusual design features.

Catalytic Section. The catalytic section of TCR units is very similar in general arrangement to the catalytic section of the smaller-size bucket-elevator type TCC units, a number of which have been built in the 3000 to 5000-bbl-per-day range.[5] Just as in these TCC units, the TCR catalytic section is arranged with the reactor and kiln side by side. Auxiliaries to the reactor-kiln system include a hot catalyst storage bin for holding the catalyst during a shutdown, a fresh catalyst bin, and an elutriator for removing fines from a continuous catalyst slip stream.

The TCR kiln operates at substantially atmospheric pressure. A kiln for a 15,000-bbl-per-day TCR unit would normally be designed to burn about 2000 lb of coke per hour, with a catalyst circulation of approximately 25 tons per hour. Regeneration is accomplished in several burning stages, with cooling between stages. Inasmuch as TCR catalyst burns quite rapidly, the average regeneration temperature is maintained in the range of 800 to 1000 F, which is approximately 200 F lower than the comparable temperatures in a TCC kiln. Control of burning is accomplished mainly by regulation of the combustion-air temperature to the various zones. Secondary control is provided by regulation of the cooling coils between burning zones. Just as in TCC units, the cooling coils also serve for steam generation.

The reactor for a 15,000-bbl-per-day TCR unit is approximately 11 ft 0 in. in diameter, and it is designed to operate at a pressure of 175 psig. The naphtha and recycle-gas feed enter the center of the reactor and flow upward and downward to suitable vapor disengaging sections. The two vapor streams which leave the reactor are combined before they enter the heat-exchange system.

The commercial reactor is provided with the same type of pressure-lock system as is used for the introduction of catalyst in the 50-bbl-per-day unit. The operations of filling, pressuring, emptying, and depressuring are controlled by a cycle timer that operates on a 10-min cycle. The valves are 8-in. plug cocks which are equipped with stellited plugs and seats with special lubrication grooving; they are of the same design as those used in the 50-bbl-per-day unit.

Spent catalyst is purged in the bottom of the reactor; and, after it has left the reactor, it is transferred to a bucket elevator. In Fig 5 this transfer system is purposely shown in diagrammatic form for the reason that alternate designs are under consideration and because no specific information can be given at this time.

Heat Exchange and Heat Recovery. Inasmuch as the heat content of the reactor effluent is large, an efficient heat-exchange system is essential to the economical functioning of the process. Fortunately the reactor effluent material is very stable, and it is possible to heat-exchange this stream directly without quenching. This insures the maximum availability of high-temperature level heat to the extent that approximately 60 per cent of the total heat removed from the reactor effluent serves to preheat the reactor input materials, and an additional 10 per cent is used to generate steam. In the design of the heat-exchange system, particular attention must be paid to the economics of pressure drop, because any pressure drop in the reactor effluent or in the recycle exchanger must be supplied by the recycle-gas compressor.

Fired Heaters. In order to avoid thermal cracking in the naphtha heater, the outlet temperature is limited to 900 F maximum, and the furnace is designed for a high heat input rate to the tubes near the outlet in order to reduce time temperature effects.

Although the recycle gas contains about 1 per cent of pentane and heavier hydrocarbons, it is estimated that no significant cracking of this material will occur at temperatures below 1200 F. Nevertheless, as an extra precaution, the recycle-gas heater is designed to minimize cracking. In addition, this heater is designed for a low pressure drop, viz., 15 psi, in order to maintain compression requirements at a minimum. Inasmuch as the recycle gas enters this heater at a comparatively high temperature (approximately 800 F) only radiant surface is used. For heat economy, the convection section of this heater is designed as a steam-generating unit and is tied in with the same steam drum which serves the kiln. This combination of features maintains the amount of surface required for heating the recycle gas to a minimum, and thus makes it possible to achieve a low pressure drop while thermal cracking effects are reduced to a minimum. The total heat absorbed by the recycle gas and naphtha in the heat-exchange system exceeds that absorbed in the furnaces by about 20 per cent.

Compression. The total pressure drop through a TCR system that operates at a pressure of 175 psig reactor pressure is approximately 70 psi. For this condition, typical pressures at several points in the system are as follows: recycle-gas compressor, 210 psig; reactor inlet, 185 psig; reactor outlet, 175 psig; and recycle-gas compressor suction, 140 psig. Because the recycle gas is circulated in large quantities, and because it has a low molecular weight, this system offers an ideal application for a centrifugal gas compressor. It is proposed, therefore, in plants with a capacity of 2000 bbl per stream day, or higher, to install a single centrifugal recycle-gas compressor which will be driven by a condensing turbine.

Absorption and Stabilization. The product stabilizer is essentially a depropanizer, from which C_4+ reformate is withdrawn as bottoms. Normally the overhead from this unit would flow to fuel gas—although, if desired, some condensate could be recovered therefrom as liquefied petroleum gas (LPG).

The absorber operates at a pressure of 200 psig, and it is designed to recover substantially all of the pentane and heavier components and about 90 per cent of the butanes from the "off" gas. Although this recovery arrangement necessitates the recycling of a small amount of C_4+ material back through the reaction system, it has been established that this design is more economical than an independent absorption and stripping system.

Polymer Removal. On some light stocks, the stabilizer bottoms can be used for motor-gasoline blending without further processing other than caustic washing. When naphthas of 400 F end point, or higher, however, are charged, or when naphthas that contain substantial percentages of cracked materials are charged, it is anticipated that the gasoline will contain about 1 per cent of polymer which should be separated. To accomplish this separation with a minimum loss of gasoline, it is proposed to provide a two-stage gasoline rerunning system. The first stage will flash overhead a substantial percentage of gasoline which contains no polymer; the second stage will make a sharp separation between polymer and gasoline of the desired end point. In the event it becomes necessary to produce aviation blending stocks, this two-tower arrangement will be satisfactory for the preparation of a sharply fractionated high-quality aromatic aviation

blending stock. Reboiler heat for these operations may be supplied with fired reboilers or, alternatively, with a recirculating hot-oil system.

An alternate method of polymer removal—one which proved satisfactory in the 50-bbl-per-day pilot plant—involves the use of a polymer knockout tower immediately ahead of the first condenser. This tower is operated at just below the dew point of the system, which is approximately 300 F. Gasoline from the recycle separator is used for tower reflux so as to control the heat balance and the amount of polymer removal.

Water Removal. The 50-bbl-per-day pilot-plant studies emphasized the need for dehydrating the recycle-gas stream. An investigation of various drying methods showed that satisfactory drying can be obtained by means of refrigeration, solid desiccant, or liquid desiccant. Although solid desiccant is the most effective for the reduction of moisture content to extremely low levels, the liquid-desiccant scheme is adequate for this application.

Economics of TCR Reforming

Numerous factors are important in an appraisal of the economics of catalytic reforming. It does not matter whether a catalytic reformer is installed in an old or a new refinery; to give optimum economic results, it must be properly integrated with other process facilities. Similarly, the properties of the crude oil processed and the octane-number target have an important bearing on the economics for a particular installation.

For purposes of illustration in the present case, a typical medium-sized modern refinery for the processing of 30,000 bbl per day of Mid-Continent pipe line crude is used as a basis for comparing the economics of installing thermal vs. catalytic reforming equipment. It is assumed that existing distillation, catalytic cracking, delayed coking, and catalytic polymerization facilities are adequate for the production of present gasoline octane-number requirements, but that reforming is necessary to provide an F-1 92 pool octane number in order to meet future competition. With this pool octane number, it will be possible to maintain a reasonable balance between the production of 95+ octane-number premium-grade, as well as lower octane-number house-brand, gasolines.

The catalytic reforming and gasoline-blending calculations are based on the use of a TCR unit to reform 3600 bbl per stream day of 260- to 410-F boiling-range [41.4 F-1 unleaded; 64.2 F-1 upon the addition of 3 ml TEL per gal] virgin naphtha for the production of a reformate with an F-1 octane number of 98 upon the addition of 3 ml TEL per gal. Reformer charge stock is prepared on the crude distillation unit while a 280-F-end-point straight-run gasoline with an F-1 octane number of 84.6, upon the addition of 3 ml TEL per gal, is taken overhead. For comparison, it has been determined that a 5700-bbl-per-stream-day thermal reforming unit would be required for the same target octane number. In this case a 5500-bbl-per-stream-day naphtha refractionator would be required to provide a 200- to 380-F boiling-range naphtha charge for thermal reforming — leaving a 225-F-end-point light straight-run gasoline for blending. It is advantageous in this case to expand an existing 1000-bbl-per-stream-day catalytic polymerization unit to 1300 bbl per stream day (catalytic polymer gasoline) in order to utilize butylenes and propylenes produced from expanded thermal reforming.

The cost of the projected TCR facilities—including a 3600-bbl-per-stream-day TCR unit, paid-up royalty therefor, and all off-site requirements—is estimated to be approximately $3,100,000. On the other hand, the cost of equipment for the thermal reforming case—including a new 5700-bbl-per-stream thermal reforming unit, a naphtha refractionator, additional catalytic polymerization capacity, as well as the paid-up royalty therefor, and associated off-site equipment—is estimated at $2,060,000.

Gasoline blends and product distributions for the alternate plans are presented in Tables 4 and 5.

The evaluation shown in Table 6 indicates, for this particular situation, net earnings for the TCR installation—over and above those of the thermal reforming and catalytic polymerization — of approximately $2000 per day. On the basis of an incremental investment of $1,040,000, a payout of 1.4 years is indicated. If it were assumed, in this refinery, that thermal cracking facilities were available for re-activation and conversion into a thermal reformer of the required capacity, then it might be possible to decrease the investment requirement for the thermal reforming case by

TABLE 4. Gasoline blends for 30,000-bbl-per-day Mid-Continent refinery.

	TCR		Thermal Reforming	
Gasoline Component	Barrels Per Calendar Day	F-1 Octane Number Upon Addition of 3 Ml TEL Per Gal	Barrels Per Calendar Day	F-1 Octane Number Upon Addition of 3 Ml TEL Per Gal
225-F-end-point straight-run gasoline	...	...	3,296	89.0
280-F-end-point straight-run gasoline	5,459	84.6	...	...
TCC gasoline	6,362	98.0	6,362	98.0
Catalytic polymer gasoline	984	106.0	1,310	106.0
Coker gasoline	814	77.5	814	77.5
TCR gasoline	2,978	98.3	...	...
Thermally reformed gasoline	...	...	4,198	87.5
Total	16,597	93.1	15,980	93.0
TEL addition for 92.0 F-1 octane-number motor gasoline, ml per gal	2.2		2.2	

TABLE 5. Product distribution for 30,000-bbl-per-day Mid-Continent refinery.

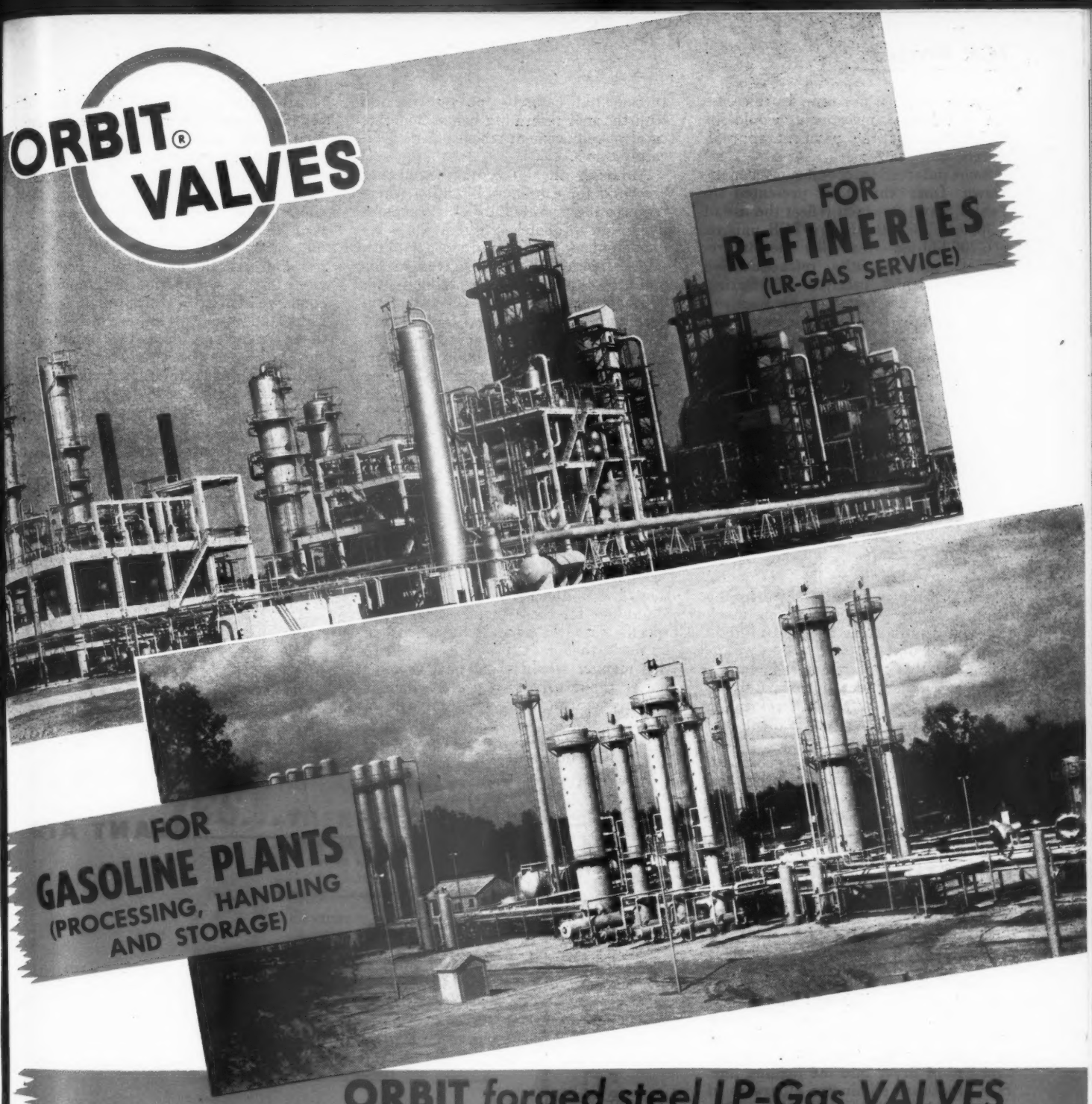
	TCC		Thermal Reforming	
Product	Per Cent by Volume	Barrels Per Calendar Day	Per Cent by Volume	Barrels Per Calendar Day
Motor gasoline	55.3	16,597	53.3	15,980
Kerosine	14.1	4,230	14.1	4,230
No. 2 fuel oil	18.9	5,676	18.9	5,676
No. 6 fuel oil—sales	2.5	733	3.7	1,101
Coke, tons	..	(141)	..	(141)
Total sales	90.8	27,236	90.0	26,987
Refinery fuel gas	7.0	2,096	7.9	2,387
Refinery fuel oil	0.5	150	..	..
Loss	1.7	518	2.1	626
Total production	100.0	30,000	100.0	30,000

TABLE 6. Economics for 30,000-bbl-per-day Mid-Continent refinery.

				Incremental	
Production Value	Price (Dollars Per Barrel)	TCR (Barrels Per Calendar Day)	Thermal Reforming (Barrels Per Calendar Day)	(Barrels Per Calendar Day)	(Dollars Per Calendar Day)
92 research octane-number motor gasoline	5.04	16,597	15,980	617	3,110
No. 6 fuel oil—sales	1.75	733	1,101	(368)	(644)
Refinery fuel	1.75	2,246	2,387	(141)	(247)
Loss	...	518	626	(108)	...
					2,219

Costs—Incremental	TCR (Dollars Per Calendar Day)	Thermal Reforming (Dollars Per Calendar Day)	Incremental (Dollars Per Calendar Day)
TEL (total gasoline)	3,528	3,397	131
Labor and burden	260	180	80
Maintenance and shops	460	267	193
Fuel (includes steam and water)	466	713	(247)
Power	71	103	(32)
Chemical and catalyst	56	54	2
Laboratory	15	10	5
Supplies and miscellaneous	5	2	3
Taxes and insurance	78	53	25
			160
Earnings: TCR over thermal reforming and catalytic polymerization			2,059
Investment—incremental			$1,040,000
Payout, years			1.4

Note:—Figures in parentheses are negative.



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approximately 50 per cent. In this case the differential investment would be $2,070,000, and the payment approximately 2.75 years.

Some interesting conclusions can be drawn from the data presented in Tables 5 and 6, which reflect the use of a 3600 bbl-per-stream-day TCR unit vs. a 5,700-bbl-per-stream-day thermal reformer, plus naphtha refractionation and incremental catalytic polymerization, to reach the target octane number:

a. Gasoline yield is increased almost 4 per cent for the same octane number by the use of TCR. This additional gasoline is produced at the expense of heavy fuel, fuel gas, and volumetric loss.

b. In the case of a refinery that produces light products only, fuel-gas production may be excessive when intensive thermal reforming is employed to reach a high anti-knock quality target. Unless LPG or petro-chemical utilization is considered, this excess gas would ordinarily be flared — particularly during summer months, when low vapor-pressure gasoline is made. This uneconomic situation may be avoided by the use of catalytic reforming which, in effect, converts fuel gas and loss to high-quality gasoline.

c. Total fuel requirements, including steam and water, are approximately 50 per cent higher for thermal reforming than for TCR. Power requirements are about 40 per cent higher.

d. Chemical and catalyst costs are almost identical for the two processes. Incremental catalytic polymerization with thermal reforming has a moderate catalyst requirement which offsets TCR catalyst cost.

Although the preceding economics are valid for a refinery situation which requires the manufacture of a comparatively low proportion of F-1 95+ octane-number premium-grade gasoline, some attention should be given to the facilities required for the production of 35 to 45 per cent high-quality premium gasoline in terms of total motor gasoline. In this case it is generally not possible to meet overall quality requirements by intensive thermal reforming plus catalytic polymerization, and the refiner must turn to catalytic reforming. Economic justification of catalytic reforming in such a situation may be established by considering the losses in revenue incurred by failure to install catalytic reforming facilities. These losses may include those associated with limited or no production of premium-grade gasoline or distress sales of excess straight-run naphtha at low prices. Although it is difficult to establish accurate values for these factors even for a specific case, the general statement can be made that a TCR unit evaluated in this manner would show payout times in the range of 1 to 3 years, which is roughly equivalent to the result shown in Table 6.

Commercial Program

Now that novel features about the catalyst, the process, and the design of the plant have been proved by extensive bench-scale pilot-plant and semi-commercial plant programs, full-scale commercial programs can be undertaken with confidence. As of this writing, the construction programs have already been announced for 4 commercial TCR units with a total capacity of 50,000 bbl per day. Also the industry has been advised of the construction program for a commercial TCR catalyst manufacturing plant. Much of the engineering of these commercial plants proceeded concurrently with the later stages of the 50-bbl-per-day semi-commercial plant program, so that now the engineering designs for these plants are complete.

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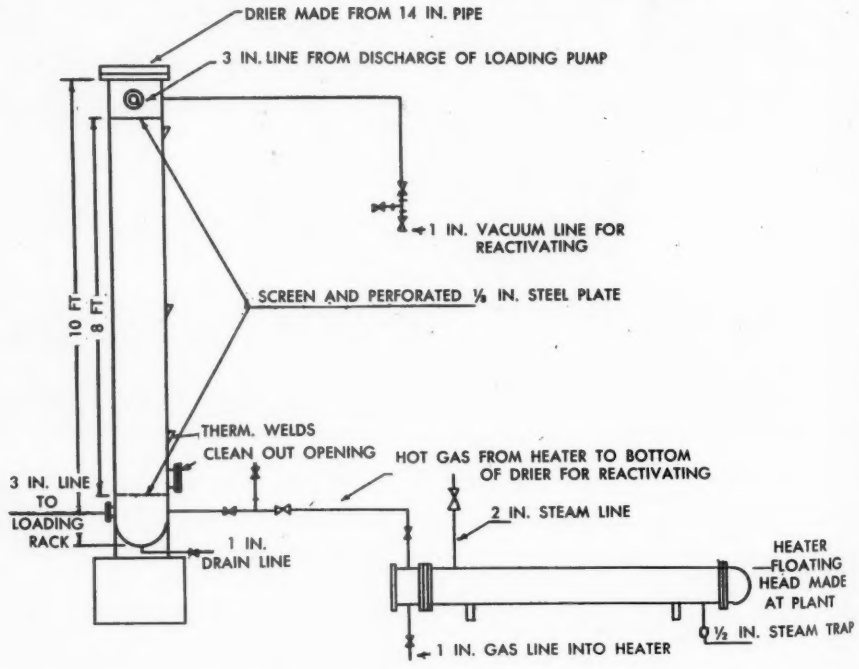
ROBERT LUPFER†

Purpose: To extract moisture from propane.

This dryer was fabricated at the plant and set on the discharge of propane pump to loading rack line. The pump takes suction from storage tanks and discharges through the activated aluminum bed of dryer into the loading line. This procedure eliminates all traces of moisture in propane. The following material was used in constructing the dryer: (1) 14 in. by 10 ft piece of standard line pipe; (1) 14 in. No. 300 flange and blind; (2) 3 in. No. 300 flange; (1) 4 in. flange and blind No. 300; (2) 1 in. collars; 2 pieces of ¼-in. steel plate 14 in. in diameter perforated for bottom and top of section for activated aluminum bed. See sketch or slide of dryer for connections and section of aluminum bed.

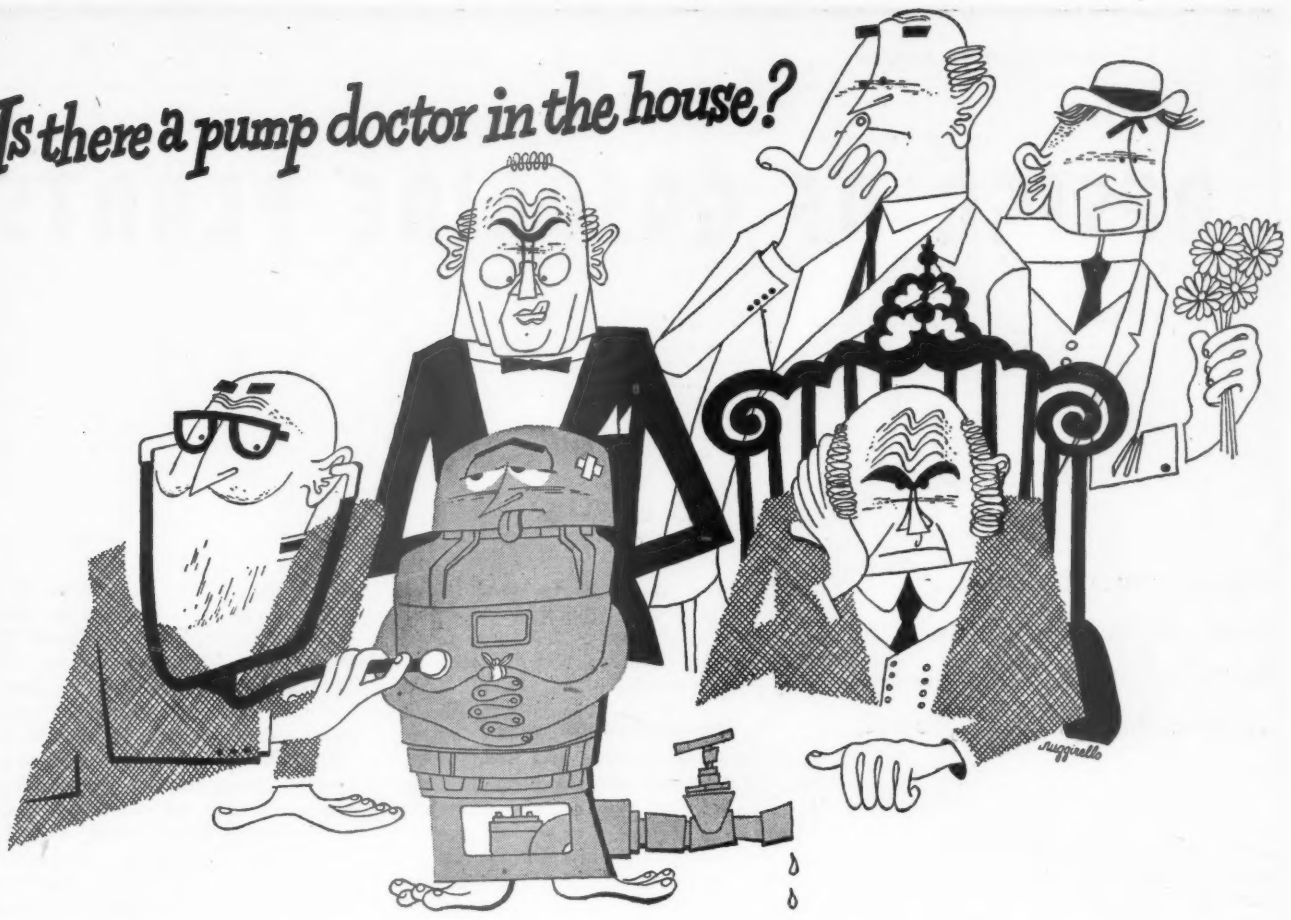
The propane from storage tanks enters the top of dryer, goes down through the 8 ft section of activated aluminum and discharges from 3 in. outlet connection at bottom into the loading line. The dryer will dry 120,000 gal of propane before any trace of moisture will show on tester. The aluminum bed is reactivated after use each day, for four hours, with hot residue gas; at the rate of 14 mcf per hour.


DRIER MADE FROM 14 IN. PIPE
3 IN. LINE FROM DISCHARGE OF LOADING PUMP
1 IN. VACUUM LINE FOR REACTIVATING
SCREEN AND PERFORATED ⅛ IN. STEEL PLATE
10 FT
8 FT
THERM. WELDS
CLEAN OUT OPENING
HOT GAS FROM HEATER TO BOTTOM OF DRIER FOR REACTIVATING
3 IN. LINE TO LOADING RACK
2 IN. STEAM LINE
1 IN. DRAIN LINE
HEATER —FLOATING HEAD MADE AT PLANT
½ IN. STEAM TRAP
1 IN. GAS LINE INTO HEATER

To reactivate or dry bed; the pressure is released through the 1-in. line tied into the plant gas intake scrubber. This is done at slow rate so as not to overload compressors during heavy gas loads. After pressure is released the hot residue gas from a heat exchanger near by is turned on and enters at the bottom of dryer passing up through the aluminum bed and out at top through the 1 in. connection to plant intake scrubber. See sketch for flow of hot gas. All gas is returned to plant intake scrubber. * *

*NGAA Second Prize Winner—Class C.
†Controls maintenance, Gregg-Tex Gasoline Corp., Longview, Texas.

Is there a pump doctor in the house?



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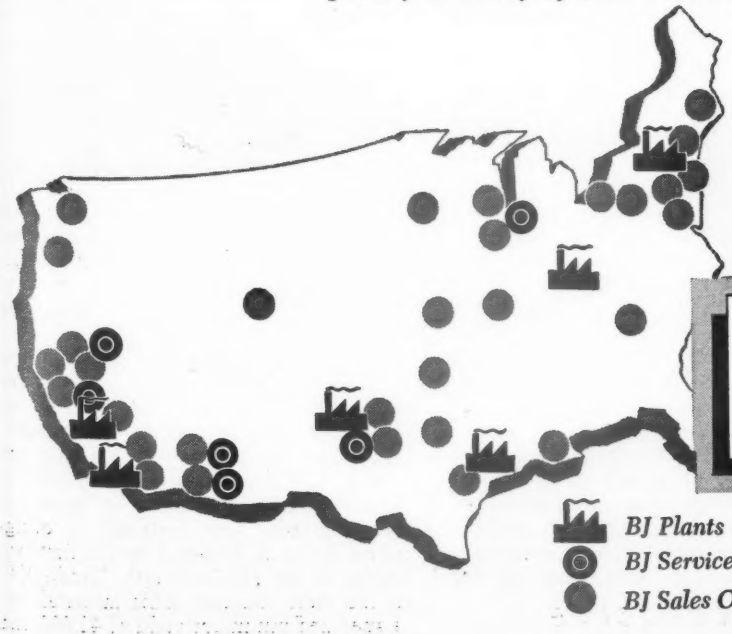
If you have a sick pump—or if you're having trouble diagnosing a pumping problem, a BJ pump specialist can help. These fully-qualified BJ Sales Engineers, working out of 31 *company* sales offices, bring you the benefit of BJ's 80 years' experience in meeting and solving every kind of pumping problem. These local Byron Jackson offices are in addition to BJ's six modern factories, six service shops, and reliable dealers. For pump engineering assistance and quick answers to your particular pumping problems, just phone your nearby BJ Branch Sales Office!



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BJ Service Shops
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Byron Jackson pump manufacturing plants are located in Los Angeles and Fresno, Calif.; Houston and Plainview, Tex.; Lawrenceburg, Ind.; and Bethlehem, Penn.

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DESIGN OF GASOLINE PLANTS

PART 5—PIPE SELECTION

O. L. LEWIS*

Piping must be selected on basis of service required, in terms of ASTM-API specifications for standard grades

SELECTION of pipe for gasoline-plant service is governed largely by the ASA Code for Pressure-Piping. The latest code is ASA B31.1-1951. Section 3, Division A, by definition includes (1) refinery process-piping systems, including air, water, steam-oil, and gas; (2) gas-processing plants (gasoline-recovery plants, recycling plants, absorption plants, and similar, but not gas-manufacturing plants), including gas-gathering systems and gas-return systems within plant limits. Steam-piping within the block-valves of the steam-generating plant is excepted from this code but is covered by the ASME Boiler Code.

The piping-materials referred to in the codes, are specified by ASTM and API. Either specification is acceptable as long as the material involved meets the code-requirements for the intended service.

Design Pressures

There are several methods of setting up design-conditions. Corrosion may not be much of a problem in the gasoline plant. Where it is, additional thickness is usually added to carbon-steel pipe for corrosion allowance.

Corrosion-resistant materials fall in a class of special design not covered here. The maximum pressure used for piping design usually can be the set pressure of the relief-valve on the apparatus the pipe connects to. If there is a possibility of closing the line off from the relief-valve, the line should be designed for the maximum shutoff pressure of the pump or compressor feeding the line. Lines that are subject to shock, vibration, or high external stress, deserve additional consideration. Compressor-discharge lines should be designed for at least 125 per cent of the relief-valve setting on the system. Lines from large reciprocating-pumps, fall in the category with compressor-lines.

*C. F. Braun and Company.

Design-Temperatures

Design-temperatures also need to be set. The normal operating-temperature is usually known within a few degrees. Again it is necessary to set design-conditions somewhat above the operating-condition. Water-line temperatures are relatively low and not subject to wide variation. A safe design-temperature is operating plus 10 per cent. Steam-line temperatures are controlled by pressure-regulation. The design-temperature may safely be set at operating plus 10 per cent with a maximum design allowance of 50 F. An acceptable rule-of-thumb for process-lines, is to set the design-temperature as the maximum *normal* operating-temperature plus 50 F. This allowance will cover upsets in operation and possibly short-time bypass conditions that are not normal.

Standard Specifications

An understanding of the range of application covered by the various piping specifications is helpful. The specifications most apt to be encountered in gasoline-plant work are as follows. ASTM A-120 is the lowest grade of pipe normally specified. Neither chemical or physical tests are called for in this specification. A hydrostatic test is required before shipment from the mill. Due to the loose specification, this material is not allowable under the Boiler Construction Code, and is limited to 450 F at low stresses under the ASA Pressure-Piping Code. About the only application in a gasoline-plant is for low-pressure fuel-gas and either black or galvanized water-piping.

ASTM A-53 is probably used more in gasoline-plant piping than any of the other specifications. The minimum tensile-strength and yield-point requirements for the seamless and resistance-welded types are the same as for ASTM A-106. Buttweld pipe is made by the acid bessemer process and the specification calls for minimum tensile-strength of 50,000, minimum yield of 30,000. Lapweld pipe is open hearth or electric furnace steel and the minimum requirements are 45,000 tensile, 25,000 yield. The chemical composition is not specific except that maximum phosphorous is set. The physical tests required are comparable to A-106, but the requirements for furnace welded types are not as strict. The material is intended for general code applications up to 750 F. In the petroleum industry, this material is seldom specified above 600 F, and it is not specified for pipe-bends.

ASTM A-106 is a quality low-carbon steel. The specification sets complete chemical-composition and physical-tests. This material is acceptable by the code for temperatures up to 1000 F. This material is preferred for temperatures over 600 F, for high pressures where creep or fatigue are considered, and for all applications requiring coiling or bending.

API-5L specification is comparable to ASTM A-106 in most respects. The chemical requiremnets are not quite as strict and the physical tests required are a little different. API-5L satisfies the same code-requirements as ASTM A-106. Different types and grades are available to cover the A-53-A-106 range. API-5L is also available in Grade C. The maximum carbon-content is not set in the specification, but may be specified by the purchaser. Maximum carbon required for the tensile specification of Grade C is .35 per cent, the minimum is .31 per cent.

The API specification for high-test line pipe is relatively new. It provides standards for a more rigorously tested pipe having greater tensile and bursting strength than pipe manufactured under API-5L. Manganese is added to increase the yield-point at moderate temperatures. The material is designated by an X followed by the first two digits of the yield-strength. Grade X42 is the most common. This material has a specified minimum yield of 42,000 and

EXCLUSIVE

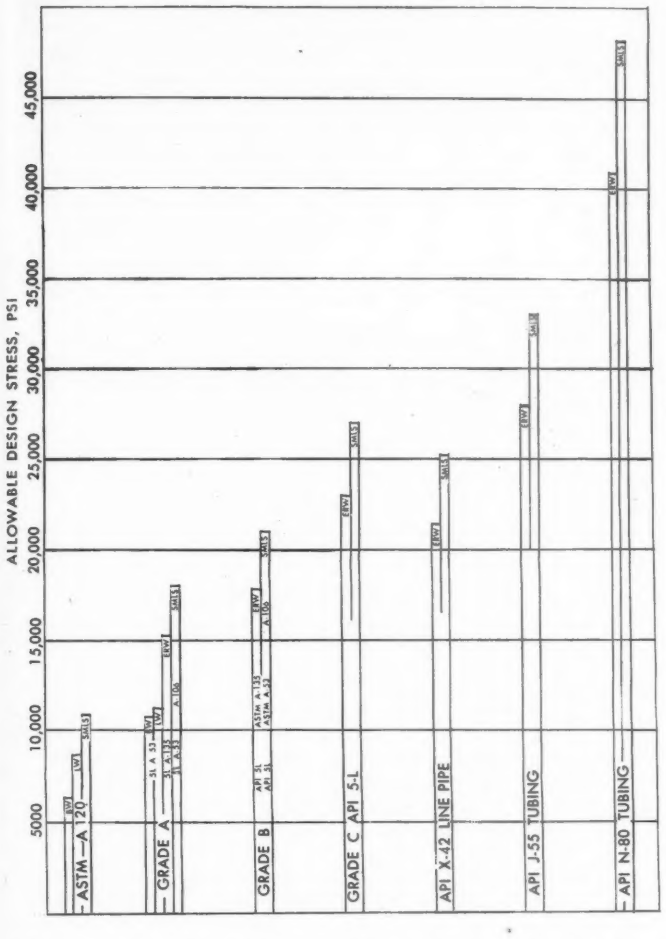


FIG. 1. Maximum design stress oil piping within plant limits—100 F based on ASA code.

BW—Furnace buttweld
LW—Furnace lapweld
ERW—Electric resistance weld
SMLS—Seamless

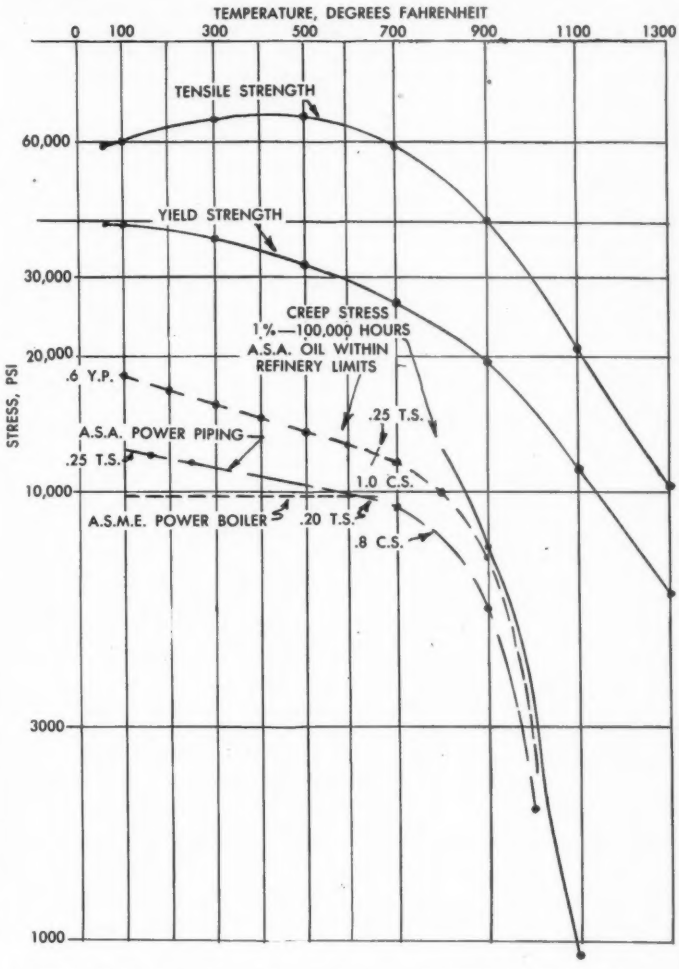


FIG. 2. Design properties carbon steel ASTM A-10b grade A.

a maximum carbon-content of only .30. This means more strength and easier welding.

API-J55 and N-80 are tubing specifications with higher carbon-content to increase the yield and tensile-strength. In the specification for API-J55, the carbon content is .33 to .42 per cent and the manganese is 1.35 per cent. These ingredients increase the yield-strength to a minimum of 55,000, the tensile to a minimum of 75,000 pounds. API N-80 is a higher tensile tubing. It is available in seamless and electric weld. The specification calls for minimum 80,000 yield, 100,000 tensile. This pipe is not suitable for welding by ordinary methods and should be used with screwed or flanged lens-joint connections.

Joint Efficiency

Pipe to most of these specifications is available either welded or seamless. The code gives the seamless pipe a joint efficiency of one. Electric resistance weld joint efficiency is .85 with the provision that a joint efficiency of 1 may be used if physical tests are made to insure that the pipe is equal to seamless in strength. The joint efficiency of lapweld is set at 80 per cent, of buttweld at 60 per cent. Due to this reduction for joint efficiency, buttweld and lapweld pipe, are not usually economical except for moderate pressures where the actual thickness requirement is well below that of standard pipe.

Sequence of Application

The normal sequence of pipe-selection then becomes (1) ASTM A-120 for domestic water and equivalent services. (2) ASTM A-53 for relatively low temperature-lines or less severe services. (3) ASTM A-106 or API-5L for higher temperature or severe service lines. Grade A lapweld with a maximum carbon-content of .25 is used if the design-pressure and temperature are within the limitations of common schedules of this pipe. When higher strength is required, Grade A seamless is next in line. Then Grade B seamless with a maximum carbon content of .30. Both Grade A and Grade B materials may be fabricated by ordinary field practice.

When the required thickness for Grade B material is greater than desired, Grade C with a carbon-content of .31 to .35, or API X-42 would probably be specified.

Recycling-plant pressure and volumes sometime reach a point where even Grade C pipe would have to be heavier than any thickness commercially available. When that condition is encountered there are two choices. Either use smaller multiple lines or specify special materials. The primary properties desired are high-yield and tensile-strength at nominal temperatures. That is where J55 and N-80 come into the picture. These materials definitely require special handling for welding. The special handling cost will more than offset the saving in pipe-tonnage, unless pressures involved are so high that no lower carbon steels are suitable.

Allowable Stress

Fig. 1 shows the comparative yield strength of common gasoline-plant piping-materials. Allowable design-stresses for the various piping-materials depend upon the chemical-composition, physical-properties, tests required, and method of manufacture. The difference in

FIG. 3A. Maximum allowable working pressures psi.

Based on ASTM A-106 grade "A" seamless pipe.
For oil piping systems within refinery limits per ASA piping code–1951–temp. 100 F.
For adjusting factors for ratings at other temperatures and/or other specifications. See schedule 3D.

Threaded pipe
Schedules and weights commonly used

	Std. Wt. Sch. #40		X Hy. Sch. #80		Sch. #160		XX Hy.	
Pipe size	Wall	W.P.	Wall	W.P.	Wall	W.P.	Wall	W.P.
¼	.088	1800	.119	3600				
⅜	.091	1600	.126	3200				
½	.109	1670	.147	3085	**.187**	4585	.294	8570
¾	.113	1440	.154	2675	**.218**	4595	.308	7300
1	.133	1260	.179	2380	**.250**	4080	.358	6650
1¼	.140	1150	.191	2100	**.250**	3230	.382	5725
1½	.145	1080	.200	1990	**.281**	3335	.400	5305
2	.154	985	.218	1835	**.343**	3485	.436	4730

Note: Pipe of wall thickness shown in bold face usually not available for prompt shipment. Check deliveries before specifying.

allowable stress between welded and seamless pipe, is based upon extensive tests. The effect of temperature upon short-time tensile strength, yield-point, and long-time creep-strength, is the same for all applications, but the evaluation of this factor varies with the industry and the service.

Petroleum and chemical industries have used higher stress-values throughout their development. And these values have been justified by an excellent safety record. The power industry, always deeply aware of its responsibility for uninterrupted service, has been more conservative. The stresses allowed for power-piping are the lowest of any of the codes.

It is interesting to look at the differences in allowable stress for the same material in different service. An ASTM A-106, Grade A line in oil-piping outside refinery limits, would take an allowable stress of 25,000 psi at atmospheric temperature. Oil-piping within the plant at atmospheric temperature has an allowable of 18,000 psi. If the temperature is increased to 450 F, the allowable stress drops to 14,150 psi. Power and district heating service allows 12,000 psi at atmospheric temperature and 10,560 at 450 F. Power Boiler Code allowable stress is 9600 psi at atmospheric temperature and 9600 psi at 450 F.

The method of arriving at allowable stress varies with the applicable codes. The ASME Boiler Code bases allowable stress on the lesser of the two following values. $S = .2E \times TS$ or $S = .8 \times CS$, where E is the specified joint efficiency. These equations apply to alloy and carbon-steels and are based on the premise that the tensile strength undergoes no reduction between 650 F and atmospheric temperature.

The ASA Code for Power-Piping agrees with the boiler code above 650 F, but differs in the lower temperature-range. Below 650 F, gradually increasing stresses are used until at atmospheric temperature, the safety factor is reduced from 5 to 4. For temperatures up to 150 F, $S = .25E \times TS$. From 150 F to 650 F, $S = .20E \times TS$. For temperatures above 650 F, $S = .80E \times C.S.$

The ASA Code for piping within refinery limits, sets allowable stresses at temperatures above 650 F, 25 per cent higher than corresponding power-piping stresses. Below 650 F, the allowable stresses increase with decreasing temperature, reaching a value of 60 per cent of the yield at 100 F. Allowable stresses within these limits, are based on $S = .6 \times YS$ at 100 F temperature. $S = .25E \times TS$ at 650 F temperature. $S = 1E \times CS$ for temperatures above 650 F.

Fig. 2 shows graphically the allowable stress of ASTM A-106 Grade A pipe under various codes. The tensile-strength, yield-strength, and creep-stress curves are plotted from actual test data of the U. S. Steel Corporation. Note that actual tensile and yield values are well above the minimum code-requirements for this material. If the actual material being used is tested, then the actual yield may be used for design instead of the specified minimum yield.

Wall Thickness

Formulas for the determination of minimum wall-thickness and maximum working-pressure, are given in the ASA code. For piping within plant-limits, the formulas are

$$T_m = \frac{PD}{2S + 0.8P} + C$$

and

$$P = \frac{2S\ (t_m - C)}{D - 0.8\ (t_m - C)}$$

An alternate formula for thickness may be used. $t_m \frac{PD}{2S} + C$. The symbols are the same in all formulas. t_m minimum design-thickness of the pipe-wall in inches (manufacturing tolerance must be added) P = maximum non-shock internal service pressure in pounds per square inch. D = outside pipe diameter in inches. S = maximum allowable stress in pipewall due to internal pressure. The allowable stress is determined at design-temperature. C = corrosion allowance plus thread depth in inches. Other requirements regarding minimum corrosion-allowance, minimum thickness, joint efficiencies, and exceptions to the rules are given in the code. The calculation of pipewall-thickness is not at all complicated. But it does take time to run through the figures, and there is always the possibility of arithmetical error. To save that time, in most cases, and to provide a check against calculations for the possibility of error in all cases, the following series of tabulated values will be quite helpful.

FIG. 3B. Maximum allowable working pressures psi.

Based on ASTM A-106 Grade "A" seamless steel pipe.
For oil piping systems within refinery limits per ASA piping code-1951—Temp. 100 F.
For adjusting factors for ratings at other temperatures and/or other specifications see Fig. 3D.

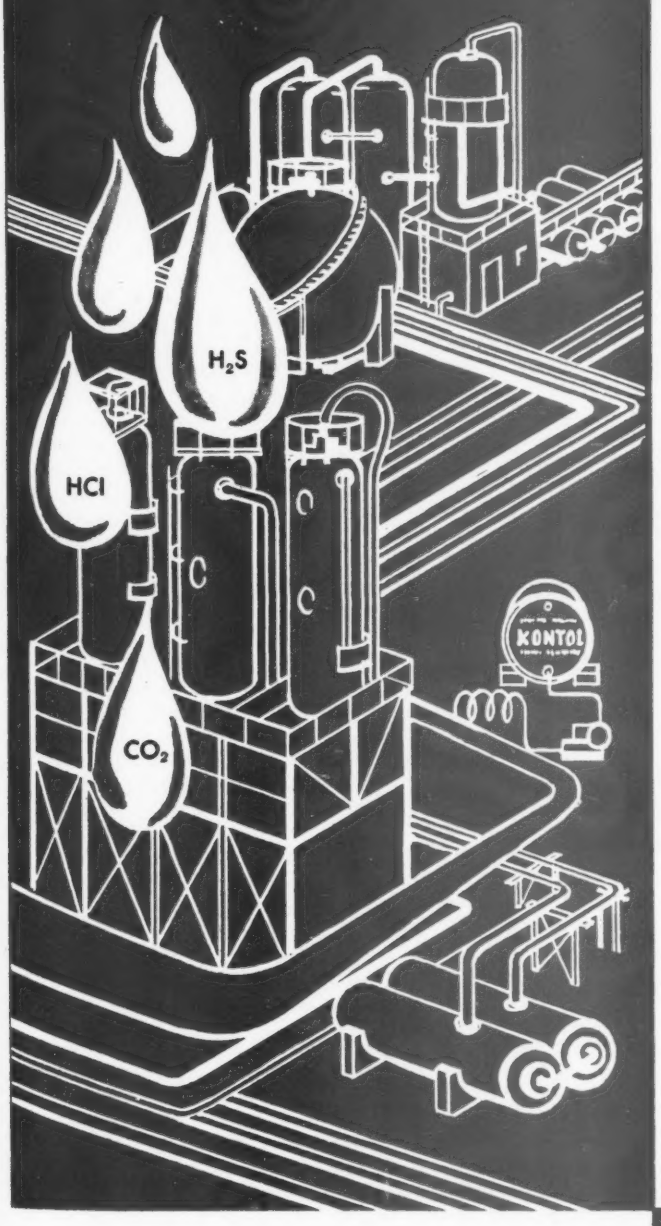
Welded pipe
Schedules and weights commonly used

	Sch. #40		Sch. #80		Sch. #160		Std. wt.		X Hy.		XX Hy.	
Pipe Size	Wall	W.P.	Wall	W.P.	Wall	W.P.	Wall	W.P.	Wall	W.P.	Wall	W.P.
1	.133	1805	.179	2930	.250	4625					.358	7200
1¼	.145	1460	.200	2370	.281	3715					.400	5685
1¼	.140	1585	.191	2535	.250	3665	Same		Same		.382	6160
2	.154	1290	.218	2135	.343	3790	as		as		.436	5030
2½	.203	1600	.276	2400	.375	3480	Schedule		Schedule		.552	5420
3	.216	1430	.300	2190	.437	3425	40		80		.600	4885
4	.237	1255	.337	1960	.531	3320					.674	4320
5	.258	1140	.375	1800	.625	3215					.750	3920
6	.280	1060	.432	1780	.718	3140					.864	3835
8	.322	965	.500	1620	.906	3100					.875	2990
10	.365	900	.593	1570	1.125	3125			.500	1300		
12	.406	860	.687	1585			.375	785	.500	1095		
14 OD	.437	855	.750	1560								
16 OD	.500	875	.843	1550								
18 OD	.563	885	.937	1540								
20 OD	.592	845	1.031	1535								
24 OD	.687	845	1.218	1525								

Note: Pipe of wall thickness shown in bold face usually not available for prompt shipment. Check deliveries before specifying.

STOP

CORROSION LOSSES



KONTOL

Corrosion Inhibitor is used effectively in the refinery to combat corrosion caused by moisture, chlorides, HCl, CO_2, H_2S and organic acids. Kontol inhibits attack by H_2S, stopping blister formation at its source.

KONTOL can be used to control the corrosion of flow lines, fractionating towers, debutanizers, depropanizers, and stripping columns. It is also effective in the protection of heat exchangers, gathering systems, separators, scrubbers and overhead products lines.

KONTOL does not affect the quality of refined products, with reference to end point, gum-formation, anti-knock rating, color, ash content and so on.

KONTOL can be continuously injected into a refinery flow system by means of a chemical feed pump, or by once-a-day batch injection by means of a lubricating device.

KONTOL provides protection against corrosion by adsorbing at metal surfaces as a thin, tough, impervious film which prevents contact by corrosive agents. It provides substantial protection against many kinds of refinery corrosion which, heretofore, have been accepted as being unavoidable.

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KR-52-S

FIG. 3C. Maximum allowable working pressures psi.

Based on ASTM A-106 Grade "A" seamless steel pipe. For oil piping systems within refinery limits per ASA piping code-1951—temp. 100 F.
For adjusting factors for ratings at other temperatures and/or other specifications see Fig. 3D.

Welded pipe — Schedules not commonly used

Pipe Size	Sch. #20		Sch. #30		Sch. #60		Sch. #100		Sch. #120		Sch. #140	
	Wall	W.P.	Wall	W.P.	Wall	W.P.	Wall	W.P.	Wall	W.P.	Wall	W.P.
4									.437	2655		
5									.500	2510		
6									.562	2400		
8	.250	705	.277	800	.406	1275	.593	1960	.718	2410	.812	2760
10	.250	565	.307	735	.500	1300	.718	1935	.843	2300	1.000	2760
12	.250	475	.330	675	.562	1250	.843	1940	1.000	2330	1.125	2635
14 OD	.312	575	.375	715	.593	1200	.937	1980	1.062	2260		
16 OD	.312	500	.375	625	.656	1185	1.031	1920				
18 OD	.312	445	.437	665	.718	1155	1.156	1925				
20 OD	.375	500	.500	700	.812	1190	1.250	1880				
24 OD	.375	420	.562	665	.937	1155	1.500	1895				

Welded pipe — Common wall thickness not conforming to schedules

Pipe size (Inches)	Wall thickness						
	Sch. #10 W.P.	5/16 W.P.	3/8 W.P.	7/16 W.P.	1/2 W.P.	5/8 W.P.	3/4 W.P.
14 OD	435	575	715	855	995	1275	1560
16 OD	380	500	625	750	875	1120	1365
18 OD	340	445	555	665	775	995	1210
20 OD	305	400	500	600	700	895	1090
24 OD	255	335	420	500	580	745	910

Note: Seamless OD pipe with wall thickness in excess of .250 in. is usually not available for prompt shipment. Check deliveries before specifying.

FIG. 3D. Adjusting factors for carbon steel pipe.

For temperatures other than 100 F and/or for specifications other than ASTM A-106 grade "A" seamless.
Based on allowable "S" value PSI at 100 F=18,000.

Temperature F	ASTM A-106 Seamless Grade A	A-106 Grade B	A-53 Lapweld and Spiralweld	A-53 Buttweld
100	1.000	1.167	0.625	0.600
125	0.983	1.150	0.617	0.592
150	.969	1.136	.611	.583
175	.953	1.119	.603	.575
200	.939	1.106	.597	.567
225	.922	1.089	.589	.558
250	.908	1.075	.583	.549
275	.894	1.061	.575	.542
300	0.878	1.044	0.569	0.533
325	.864	1.028	.561	.525
350	.850	1.014	.556	.517
375	.833	1.000	.547	.508
400	.817	.983	.539	.500
425	0.803	0.969	0.533	0.492
450	.786	.956	.525	.483
475	.772	.939	.519	.475
500	.756	.922	.511	.467
525	.742	.908	.506	.458
550	.728	.894	.497	.450
575	.711	.878	.489	.441
600	0.697	0.864	0.483	0.433
625	.681	.847	.475	.425
650	.667	.833	.469	.417
675	.658	.819	.464	.411
700	.642	.792	.455	.400
725	.625	.764	.447	.386
750	.606	.722	.436	.372

Note: Specification ASTM A-53 not to be used at temperatures exceeding 750 F.
This chart is not extended to higher temperatures as design temperatures above 750 F are not usually encountered in gasoline plant work.

Selection of Pipe

The allowable design-pressures are tabulated in Figs. 3A through 3D. The tabulations are based on the requirements of the Code for Pressure-Piping, ASA B-31.1-1951, Section 3, Division A. The wall-thicknesses listed are nominal. The design-pressures are corrected for a 12½ per cent manufacturing tolerance, and ASA correction factors of .05 for ¼-in. and ⅜-in. threaded pipe, .057 for ½-in. and ¾-in. threaded pipe, and .07 for 1-in. to 2-in. threaded pipe, and .05 for welded oil-piping. The pressures tabulated are directly proportional to the net wall-thickness.

These schedules are not applicable to power boiler piping or oil-piping outside plant limits. Air and gas-piping may be checked with these tabulations, but the minimum design-pressure is 180 psi and the maximum allowable temperature is 450 F. The following example illustrates the use of these schedules. Example: Determine the weight pipe required for a 6-in. vapor line at 1600 psi, 250 F. Look at Fig. 3B for 6-in. welded pipe. Schedule 40 pipe has an allowable pressure of only 1060 psi. Schedule 80 has an allowable of 1780 psi at 100 F. Then look at Fig. 3D. The temperature-correction factor for A-106 seamless Grade A pipe at 250 F is 0.908. Then 1780 × 0.908 = 1616 psi allowable at the design-temperature. This allowable is within the code-requirement for Schedule 80 Grade A pipe. If the line is subject to vibration or severe external stress, the margin of safety might look a little thin. A recheck of Fig. 3D shows that the temperature-correction factor for Grade B seamless is 1.075. Then 1780 × 1.075 = 1914 psi allowable for this specification. So A-106 seamless Grade B pipe would be indicated for the more severe service.

Pipe-schedule numbers are an approximation of the value of the expression, schedule-number = 1000 P/S where P is the internal pressure and S is the allowable fiber stress at atmospheric temperature. Schedule-numbers are now almost universally accepted for all pipe-sizes through 8-in. and ½-in. wall. Larger and heavier pipe than this is sometimes more available in the old standard or extra-heavy classifications. Figs. 3A through 3C indicate the normal availability of various pipe-thicknesses.

Specifying Pipe

With the design-conditions set and the yield- strength requirement known, the selection of pipe is governed by the most economical size and material suitable for the service. Standard sizes and thicknesses are always available at lower prices and better delivery than special pipe. It is usually economical to go to the next heavier standard wall-thickness instead of calling for an odd schedule or special material. This is especially true if the quantities of pipe involved are less than required for a mill-rolling.

With design-conditions set, code-requirements met, and most suitable pipe selected, take one precaution to insure getting what you want. In specifying pipe, always give the buyer complete information: (1) Nominal inside diameter under 14 in., nominal outside diameter 14 in. and over; (2) schedule-number or nominal wall-thickness; (3) ASTM or API specification number; (4) grade of pipe desired; (5) method of manufacture—seamless, lapweld, or buttweld. (6) The type of end—threaded, beveled for welding, or plain end. Complete information on the original purchase-request saves a lot of time, questions, and misunderstandings later. * * *

The next article in this series will be published soon.

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When the Pan American Refining Corporation made a thorough study of the effects of salts in the crude charge, their conclusions were that the charging of high-salt-content crudes resulted in low charging rates, short runs, excessive down-time, high repair costs, frequent equipment replacements and excessive strain, wear and tear on equipment. To prevent these difficulties a Petreco Electrosphere Desalter was installed.

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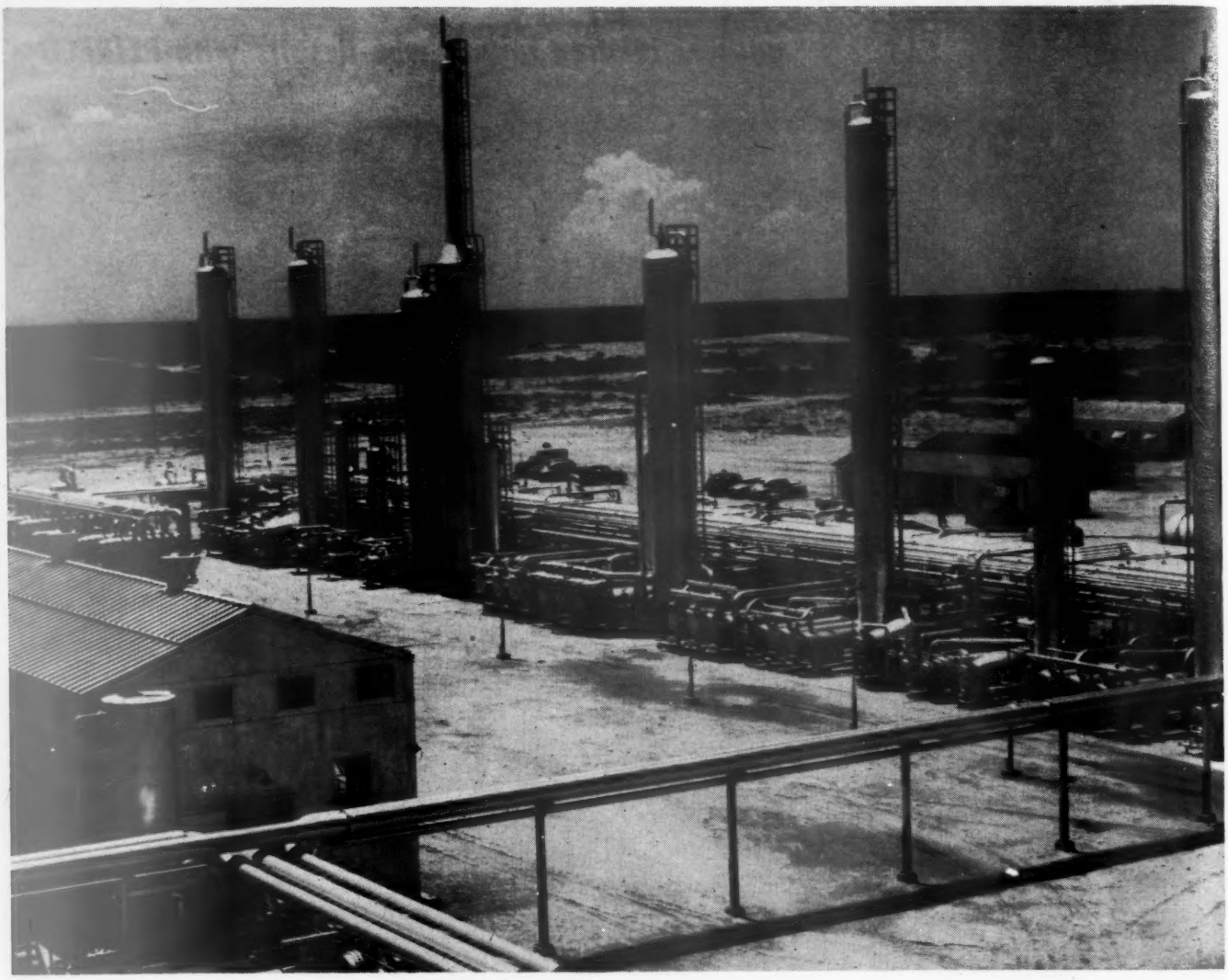


Typical absorption plant.

Liquid Recovery From Hydrocarbon Gases†

Most efficient method must be selected after consideration of specific conditions to be met, specific results desired

T. H. ANDERSON, JR.* AND W. E. COLBURN*

EARLY gas-recovery plants were built to recover a 12 to 26-lb Reid Vapor Pressure product. Liquid butanes and propanes were revaporized. About 1922, the so-called bottled gases found markets for these surplus liquids. The LPG—liquefied petroleum gas—industry came into being. It began with 223,000 gal of bottled gas sold in 1922. Last year, the industry sold 3 1/3 billion gallons of LPG.

In the early days of the industry, not much was known of the behavior of hydrocarbons. The first plants were designed with more horse-sense and dead-reckoning than technical data. But our scientific knowledge of the light hydrocarbons has grown with the industry. Now the process-engineer has the tools to predict accurately the performance of any part of his plant.

This wealth of scientific knowledge has taxed the ingenuity of the engineer to squeeze the most out of his chosen recovery-process. But it is not within the scope of this paper to discuss the variations that can be used to increase recovery or improve performance. First, the engineer must select the basic cycle he will use. It is this first step that we treat in this paper.

There are four basic ways to recover liquids from wet gas. 1. Adsorption. 2.

†Presented before California Natural Gasoline Association, 1951.
*C. F. Braun Company.

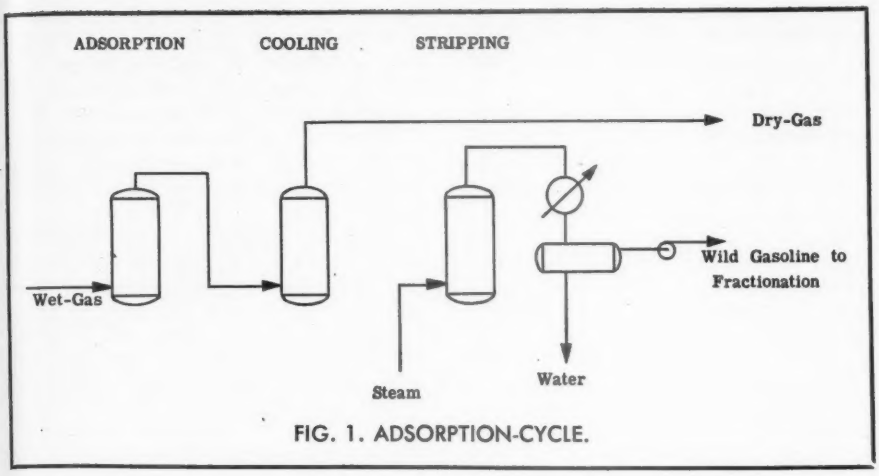


FIG. 1. ADSORPTION-CYCLE.

Condensation. 3. Gas Fractionation. 4. Absorption. Let's take a look at each cycle.

Adsorption

The use of a solid adsorbent is a well-known method for removal of components from vapors. This process was used in some of the early gasoline-plants. Activated coke was the usual adsorbent. The adsorbent, however, picks up only a part of its total weight before it becomes saturated and must be regenerated. Thus a large volume of adsorbent and batch-operation are necessary.

Fig. 1 shows a simplified flow diagram of the adsorption process. In the first step wet gas goes through a bed of activated coke. The dry gas goes to the second step. Here the gas cools a bed of hot stripped coke. In the third step adsorbed gasoline is stripped by turning steam into the coke bed. The gasoline leaves as vapor. It is condensed, separated from the water, and sent on for fractionation.

Let's look at an adsorbent plant for 30,000 gal per day of liquid-recovery. This is some 150,000 lb per day. According to Perry's Chemical Engineer's Handbook coke will adsorb about 15 lb of gasoline per 100 lb of coke. At 4 hours per step, we need 250 tons of coke. It is easy to see why these coke plants disappeared from the scene long ago.

The adsorbent cycle is selective, however. By proper control, the desired component can be picked out and recovered. The Hypersorption process takes advantage of this property. It overcomes another drawback, batch operation, by the use of a moving bed. This process is in commercial use for ethylene recovery. So far we have seen no reports on the commercial use of this process for propane and heavier fractions.

Until further refinements are developed, the adsorption cycle should be neglected by the process-engineer. One exception—the case of ethane or ethylene recovery. In such instances, the Hypersorption process may prove attractive. But as this process is a specialized cycle, we have not considered it in the general case of liquid-recovery from hydrocarbon gases.

Condensate Fractionation

Condensate was the first method of recovery—the drips from the gas-lines. These drips were wild and quickly evaporated at reduced pressure. Compression and condensation increased the yield. Subsequent rectification stabilized the product. But as long as the dry gas was separated directly from the condensate, some gasoline vapors were lost.

Where rich gases are available, the compression condensation cycle is often attractive. Only one fractionator is required. The gas off the condensate is small and the gasoline losses approach a negligible quantity.

Fig. 2 shows a simplified flowdiagram of a condensate fractionator. Here the wet gas is cooled, first by heat-exchange with the dry gas, then by refrigeration. The condensate separates in the accumulator and is pumped to the fractionator —a conventional non-condensing rectifier except refrigerant is used to condense top reflux. The top product goes direct to dry gas. The bottoms spill down into the fractionation system.

This cycle gives a constant-composition feed to the fractionator. A boon to the operators where widely fluctuating gas-rates are encountered. However, where refrigeration is necessary for desired recovery, hydrates are a problem. In such cases, drying of the feed is a must.

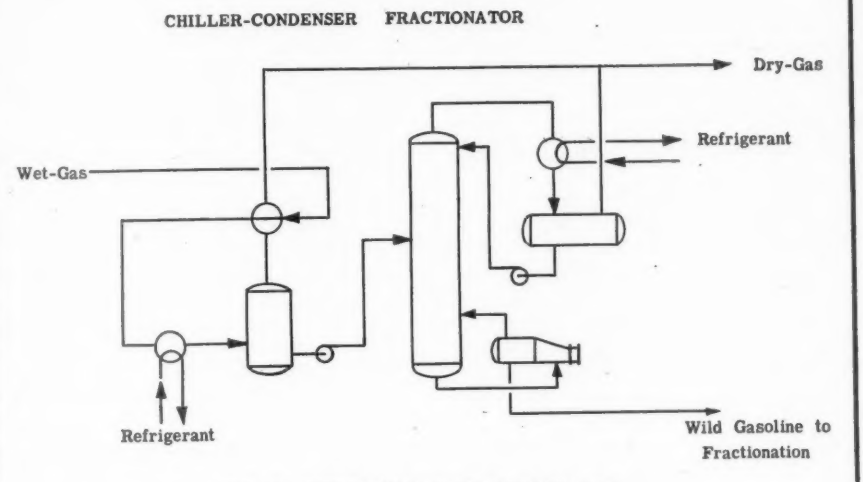


FIG. 2. CONDENSATE-FRACTIONATOR.

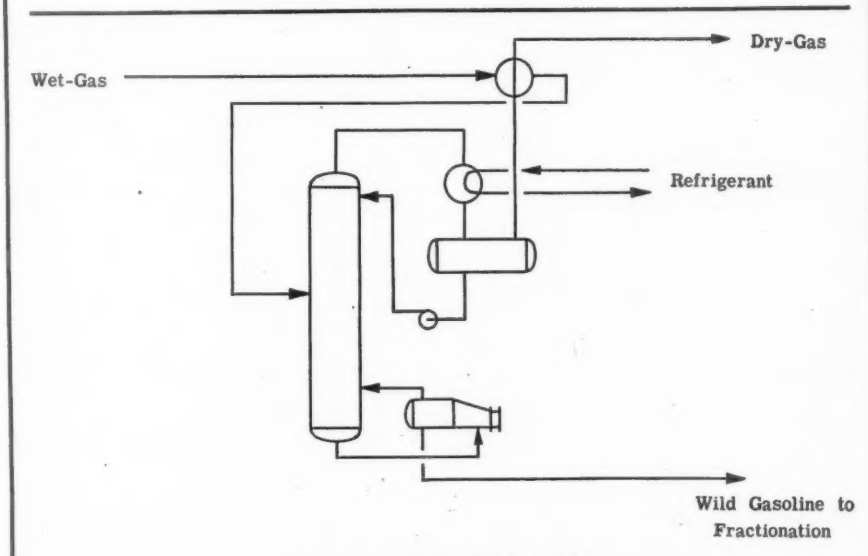


FIG. 3. GAS-FRACTIONATOR.

Gas Fractionation

The loss of gasoline in the condensate-fractionation cycle challenged the process-engineer. He came back with gas fractionation. Here he compresses and cools the wet gas. Then feeds the mixture to a single fractionating-column. This column splits the wet gas on a key component. The lights go out as dry gas. All the heavies come out in the bottoms liquid and spill down to the fractionators.

Fig. 3 shows a simplified flowdiagram of this process. The compressed and cooled wet gas leaves the dehydrating unit. The gas is cooled by exchange with dry gas off the reflux drum. The cooled mixture goes direct to the fractionating-column. This is a conventional non-condensing rectifier. The overhead is cooled by refrigeration. All the condensed liquid is pumped back as reflux. The uncondensed vapors go off as the dry-gas product. A conventional steam-reboiler is used on the bottoms. The bottoms liquid spills down to the fractionators.

Once again the engineer found himself limited to a relatively rich gas. He had to operate the column below the critical pressure of the bottoms. And he had to have enough pressure or a sufficiently low temperature in the reflux drum to have liquid in equilibrium with the dry gas. Often this required hydrate-forming temperatures. And is such cases, drying of the feed is necessary.

Absorption

The absorption-cycle gave the engineer the answer to high pressures and low temperatures. Using absorption oil, the designer could operate above hydrate-forming temperatures. Pressures could be adjusted to suit the specific plant-conditions. Variation of the oil rate was all that was necessary to obtain the desired recovery.

Here was a cycle that could operate under any plant conditions. This is the cycle that became and still is the backbone of the vapor-recovery industry. But it was no Utopia.

The adsorption oil picked up every component in the wet gas. It took two stills to strip the oil. The primary still-pressure was a delicate balance to keep recycle vapors down, and excessive light ends out of the fractionating system. Low absorber-pressures took high oil-rates. High absorber-pressures cut the oil-rate but hiked the recycle. The engineer used vent tanks and reabsorbers to get the recycle under control. About 10 years ago, he came up with the fat oil fractionator. This column enabled him to kill the recycle and use a single still. But no matter how the engineer struggled, he still had to have at least three columns and a sizable oil circulation rate to make his recovery.

A simple three-column absorption system is shown in Fig. 4. The absorber removes the gasoline and LPG from the wet gas. The fat oil fractionator takes the dry-gas fractions out of the fat oil. The overhead gas usually goes to plant fuel. Any excess is recompressed to dry gas. The stabilized fat oil goes to the stripper. Heat and steam are used to split the gasoline out of the fat oil. Lean oil comes out the bottom of the stripper. Steam and recovered fractions out the top. They are condensed. The water is separated and drawn off in the accumulator. The wild gasoline is pumped to the fractionators.

Choice of Cycle

As usual, we find several features we like and several things we would prefer to avoid in each cycle. The engineer must first select the best cycle for his recovery. Then work out the refinements. If he works up all cycles with refinements, he finds himself in an endless task. He must choose at the start. And we confine our discussion to the basic factors he needs to make his selection.

Feed rate affects the size of equipment. Variations in rate may temper his selection. But such factors affect all cycles in about equal proportions. The richness of feed and the entering pressure levels are basic factors that help make one cycle more economical than another.

The same recovery makes the same raw gasoline. The number of liquid products will set the number of columns in the fractionating section. Thus the fractionation section will usually be the same for all cycles. But the per cent recovery makes the big difference.

Dry-gas conditions at plant limits play a major role. The pipe line or repressuring pressure usually sets the maximum pressure in the plant. The exception is in refinery gas plants. There, tail-gas pressures are so low the engineer must use higher pressures to keep equipment sizes within bounds.

Pipelines have had their troubles with hydrates. If the tail-gas is sold, it often has to meet a low dewpoint. In such cases, drying equipment is required and the engineer can use temperatures down to the dewpoint. Pressure maintenance, cycling, and refinery gas plants as a rule use the dry gas before it can be chilled to hydrate-forming temperatures. In these plants, the engineer must keep his temperatures out of hydrate zones or save enough to justify a drying system.

Utilities are not a problem at this stage of the process-design. Utility levels can be adjusted within reasonable limits without materially affecting the economics of the design. Limiting cooling-water temperature is the one fixed item. The engineer must stay within this limit or be prepared to pay for refrigeration.

We have three factors to consider when selecting our basic cycle. First, the feed gas—its composition, rate, and entering pressure. Second, the recovery or range of recovery desired. Third, the dry gas—its exit pressure and dewpoint. And we keep our eye on the cooling-water temperature.

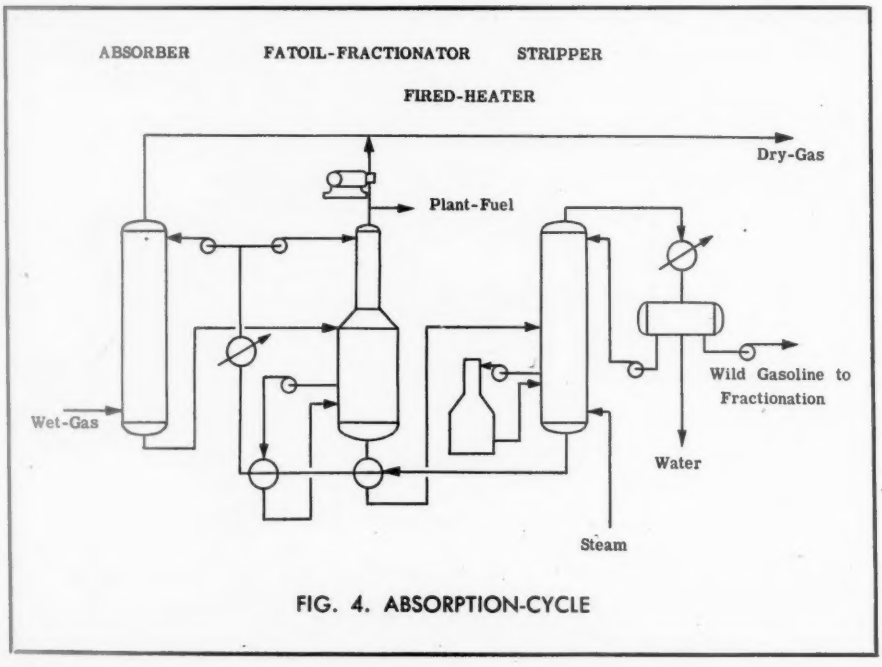


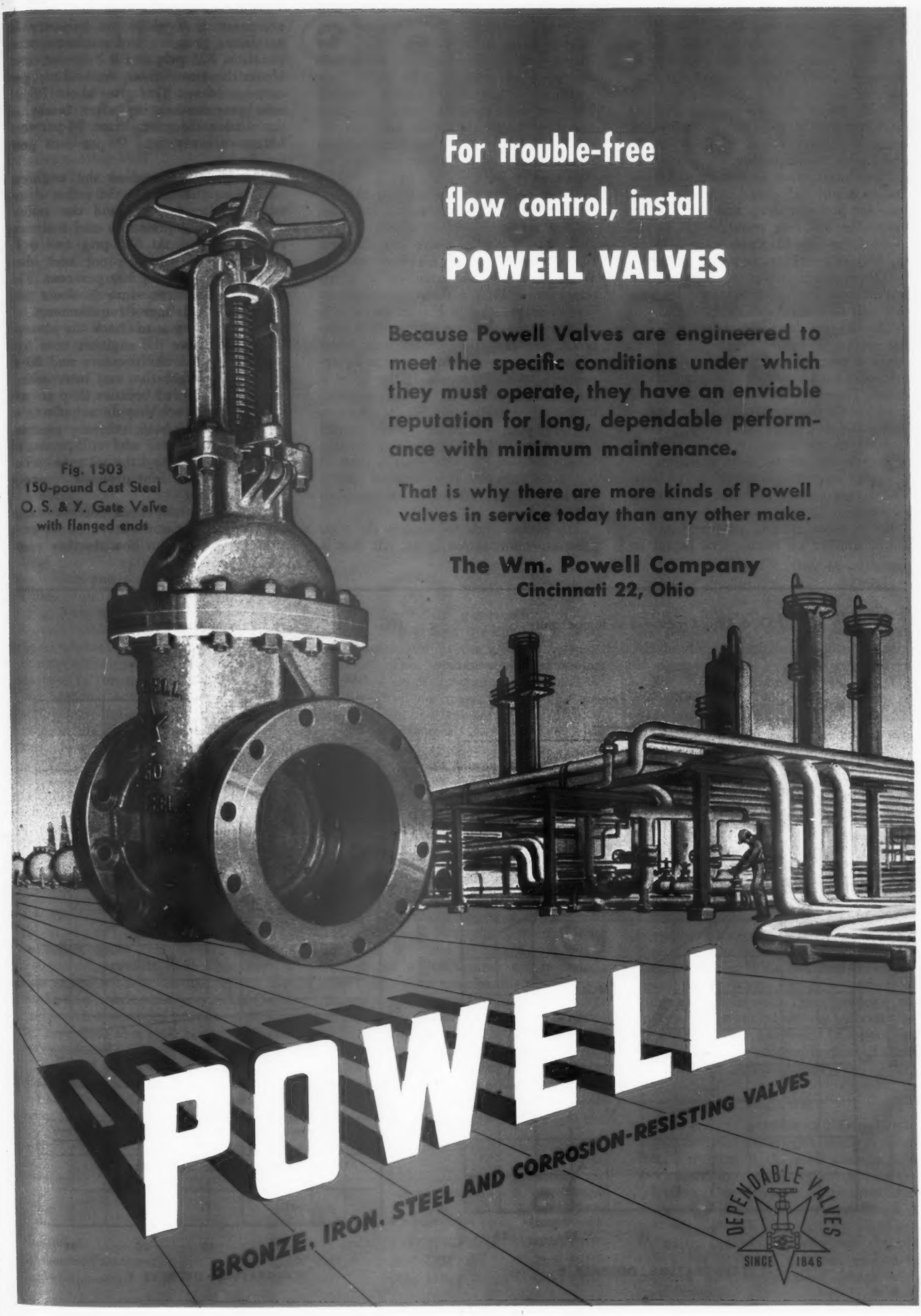
FIG. 4. ABSORPTION-CYCLE

Example

Let's follow the engineer as he applies these factors in the selection of a cycle. In our example the feed is 24,000,000 std cu ft per day of wet gas. The pressure at the plot-edge is atmospheric. The gas composition is

Composition	Mol Per Cent
C_1	52.5
C_2	25.8
C_3	13.8
iC_4	2.0
nC_4	3.7
iC_5	.7
nC_5	.6
C_6+	.9
	100.0

The dry gas will be sold. The sales contract calls for the gas to be delivered at 500 psig with a –10 F dewpoint. LPG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propane, butanes, and 20 RVP gasoline are the liquid products, with 75-per cent maximum propane-recovery to meet winter demands. Cooling-water temperature for design is 70 F.

With these conditions, the process falls into four steps. First, compression. Second, drying. Third, liquid-recovery. and fourth, fractionation.

The compression section must lift the gas to about 535 psig. This allows 35 psig for pressure drop and control and meets the 500 psig requirement at the plant fence. As this pressure is below the 800 psig retrograde point, all cycles will be more efficient at this top pressure level. Thus the same compression section will be common to all cycles.

The dry-gas dewpoint requires a drying section. Pressure assists the drying, so the drying section goes after the compressors. Either wet or dry gas can be dried. There would be little difference in either drying section. It is preferable to dry the wet gas, as this gives greater latitude in the recovery process. Then temperatures can be used down to the dewpoint without encountering hydrates. The drying section becomes common to all cycles.

Both condensate and gas fractionation would deliver an ethane-free liquid to the fractionation section. An absorption section using a fat oil fractionator for 75-per cent propane-recovery would also deliver an essentially ethane-free raw gasoline to the fractionation section. Thus we can expect the same raw-gasoline feed from any cycle and the engineer can eliminate the fractionation section from considerations affecting his choice of cycle.

By these quick evaluations, the engineer finds he can focus his attention on the recovery section alone. But he must stay within pressure and temperature limits; 500 psig is his pressure limit. With 70 F cooling-water, 80 F is his temperature limit without refrigeration. With refrigeration 0 F is a reasonable minimum temperature with a –10 F dewpoint. Any increased pressure or lower temperature would require extra equipment in another section. If the cycle is not economical within these temperature and pressure-limits, the chances are practically nil that it could justify both additional equipment and become the optimum cycle at the same time. It is a good rule that the engineer should not look outside his limits for the optimum cycle.

The easiest cycle to check is the compression-condensation cycle. All that is necessary is a check on recovery at maximum pressure and minimum temperature, 525 psig and 0 F in our case. Under these conditions, some 43 mol per cent condenses. This gives about 79-per cent propane-recovery after losses in the condensate fractionator, 94-per cent butane-recovery, and 99-per cent pentanes-plus.

For gas fractionation the engineer checks equilibrium in the reflux drum between the dry gas and the reflux. Again limiting pressures and temperatures are used. At 525 psig and 0 F, propane-recovery is 75 per cent—isobutane and heavier, 100 per cent. The bottoms critical pressure is about 650 psig. This cycle meets requirements.

The next step is to check the absorption cycle. Here the engineer uses 525 psig main absorber pressure and 80 F lean oil. Refrigeration and intercooling are not considered because they are refinements. As such they do not affect the selection of the basic recovery process. Fat oil fractionator and still-pressures are established. And the oil rate calculated for 75-per cent propane recovery —340 gpm.

Often this initial check eliminates one or two processes at the start. In our case all are tenable. But how do they com-

FIG. 6. Liquid recovery vs temperature.

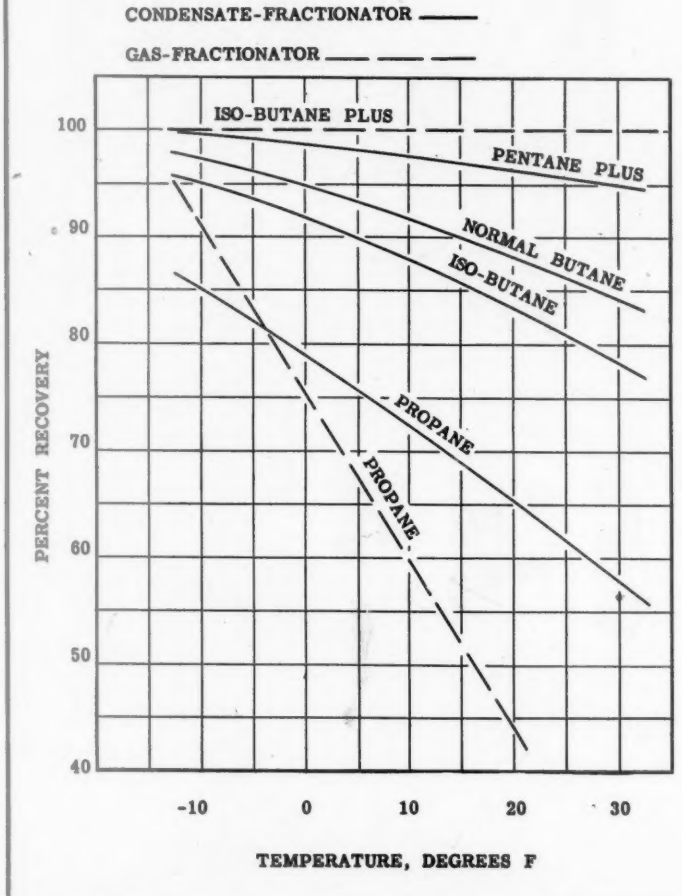
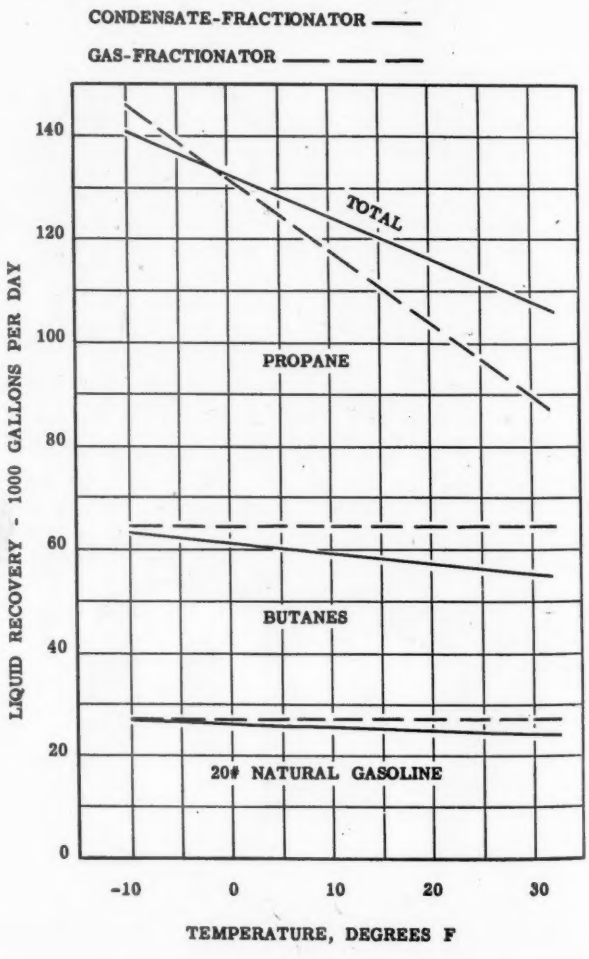


FIG. 5. Per cent recovery vs temperature.



pare in cost and utility-consumption? The engineer rough-sizes and rough-prices each cycle. He approximates the fuel and steam requirements. For a common denominator we convert all heat to fuel. This shows the gross heat input. Since the feed and products enter and leave at essentially the same temperature, the fuel requirement indicates the relative cooling load.

Table 1 shows the approximate costs, fuel requirements, and compressor horsepower. Plant costs are total for the plant ready to operate but less operating supplies, chemicals, and the like. The total fuel figure includes direct fired fuel, steam converted to fuel at 80-per cent efficiency and compressor fuel both for gas and refrigeration. Compressor horsepower is total for gas-compression and refrigeration. The absorption plant would cost around $3,750,000. Either fractionator around $3,500,000. Comparing utilities, the total fuel for the absorption plant would be $2,500,000 std cu ft per day, but only 2,000,000 std cu ft per day for the fractionators. Some 6000 hp are required for gas-compression. Refrigeration requirements raise the horsepower to 7300 for condensate fractionation; 6900 for gas fractionation. The gas and condensate fractionators are a standoff. They run a shade under the absorption plant in capital investment and some 20-per cent under in fuel requirements.

Fig. 5 shows the variation in per cent recovery with temperature for the gas and condensate fractionators. The temperature shown refers to the lowest temperature in the unit. In the condensate fractionator it occurs at the outlet of the condensate chiller, and in the reflux drum on the gas fractionator. The solid lines show the condensate-fractionator recovery. With rising temperatures propane-recovery falls off at a good rate. Butane recoveries drop, but not as fast. Pentanes-plus fall slightly. This is typical for condensate fractionators.

The broken lines show the gas-fractionator recoveries. Here the propane-recovery falls rapidly with increasing temperature. But the isobutane and heavier stay at 100 per cent. This is typical of gas fractionators. In our case, the reflux drum temperature sets the propane-recovery. It is flexible over a wide range without disturbing the isobutane and heavier recovery. This fits in nicely with a seasonal propane demand. But how does this look in terms of gallons produced?

The total gallons produced per day by the gas and condensate fractionators is shown in Fig. 6. Again the solid lines show the condensate recovery, the broken lines the gas-fractionator recovery. At 0 F both the condensate and the fractionator produce the same total gallons. The condensate fractionator produces more propane, less butanes, and a little less gasoline than the gas fractionator. But the butanes and gasoline are worth more than propane. Also the propane demand in our case is seasonal. During the summer the condensate fractionator has to condense the propane to hold a high butane and gasoline recovery. The gas fractionator can reject propane by increasing the reflux temperature. No butanes or gasoline are lost and the refrigeration load is lightened when cooling-water conditions are most adverse.

The first photo shows a typical absorption plant. Normally 7 columns, in this one 9, since hydrogen-sulfide removal and a deethanizer are included. The deethanizer enables this plant to get 80-per cent or better propane recovery. From left to right we have the hydrogen-sulfide removal unit. The absorber and then the regenerator. The two small columns are the dehydrating unit. First the regenerator. Then the absorber. Next is the main absorber. The milk-bottle column is the fat oil fractionator. Then the stripper, followed by the depropanizer, the deethanizer, and the debutanizer. All in the line of flow. Quite a string of equipment.

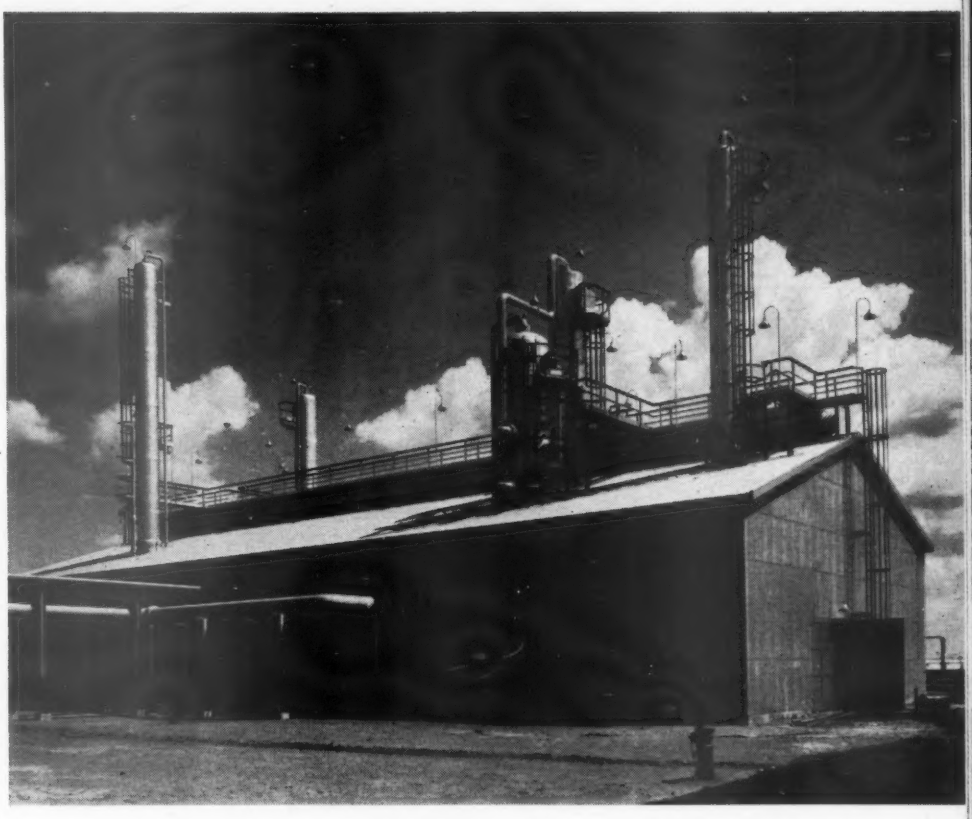


FIG. 7. Gas fractionator.

Fig. 7 shows a gas fractionator. The equipment is housed for operation in 40-below-zero weather. The column in the right foreground is the dehydrator regenerator. The two center columns are the gas fractionator in the left front and the dehydrator absorber immediately behind on the right. In the left foreground is the depropanizer and in the background the debutanizer.

Five columns to do the job, and in the liquid-recovery and fractionation sections, all conventional rectifying columns.

The economics point to the gas-fractionation process for these conditions. The first cost is slightly under the absorption cycle. With less fuel there are lower utility costs. There is no loss of butanes and heavier. The propane recovery can be varied widely without loss of butanes and gasoline. In operation we have a single column instead of three to make our liquid recovery.

Conclusion

It is not the purpose of this paper to imply that the absorption cycle is obsolete. Far from it. A small change in a key condition could make absorption the selection. Our purpose is to show that the comparison of recovery processes is not complicated. The process engineer by using the proper data can quickly select his recovery process, and then proceed with his detailed design with confidence. * * *

TABLE 1.

	Rough Price	*Approximate Fuel Consumption*	*Approximate Compressor Horsepower*
Absorption	$3,750,000	2500 MSCFD	6000 BHP
Condensate-Fractionation	$3,500,000	2000 MSCFD	7300 BHP
Gas-Fractionation	$3,500,000	2000 MSCFD	6900 BHP

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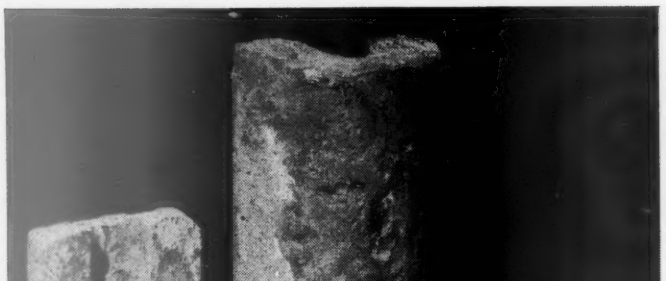

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THE SAME THREE PIECES are shown in this unretouched photograph after they were cleaned by holding them under a water faucet and rubbing by hand, then dried with an electric fan. These pieces are still usable—*proof* of Kaylo Heat Insulation's resistance to water damage. Other Kaylo Heat Insulation, already installed at this plant, was under water during the flood, yet is still in place and performing efficiently.

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ELECTRIC POWER IN OIL REFINING*

With increased demand for petroleum products, it is likely the refining branch will become a heavier user of electricity

H. M. STEWART

ELECTRIC power consumption in the typical oil refinery has increased during the past 20 years or so from about one kilowatt hour per barrel of throughput to three or four kilowatt hours—sometimes higher. This very substantial increase in power usage, in the face of our ability to use power more efficiently, reflects the increase in the intensity and complexity of refining operations required to make petroleum products today. Where a few simple steps were required in the refining operation, a number of additional complex steps are now necessary to make the increasing number of new and better products. Better processing explains why today's corner filling station sells a better grade of gasoline than that which powered Lindbergh's Trans-Atlantic flight.

The greater part of the electric load is used for pumping oil through process units, for circulating water to condense and cool process streams, for moving products to storage and to the transportation system that will deliver the finished products to market. The water pumping load is substantial, as some 20 to 25 bbl of water must be circulated for each barrel of throughput to the typical refinery. With increased demands for petroleum products and with the additional processing that will be required to make some of the still newer and better products, it is likely that the refining industry will probably need improvements in the reliability of power supplies. Records indicate that oil refineries in this country purchase about two-thirds of present power requirements. A fair portion of new requirements are likely to be purchased in the future.

From the time when lighting was about the only thing electricity was used for, on up to the present time, the oil refining industry has gone through a gradual process of electrification until it is now estimated that some 60 per cent of its requirements for motive power are supplied electrically. Several factors have favored this trend.

Electric power has proved to be an economical source of energy for refining operations. Not the least of the factors that have made this possible, are high power factor and high load factor that characterize refinery power loads, and permit the power supply operation to earn almost continuously something near the maximum realizable return on the amount invested in equipment. Most oil refineries in this country are situated near centers of population and can be supplied from utility company lines that serve the general area. Thus, they are generally within economical reach of a source of purchased power to supply all or part of the electrical needs.

In some cases, where the steam and power balance has been favorable to a non-condensing turbine generator operation, refineries have been able to meet various percentages of their power requirements by this method. So as a general thing, relatively cheap power has been available to refineries in the form of purchased power, locally generated power, or some combination of purchased and generated power.

The power industry as a whole has maintained a sound and aggressive sales program. It did not wait for its customers to beat a pathway to its door, but sent its engineers out to show businesses of all kinds where worthwhile savings could be made and where attractive returns could be earned on investments in electrification programs. The customer, as well as the power industry, has benefited greatly from this program, especially where the customer did not have an engineering staff of his own.

The availability of better equipment has also contributed to the electrification of refineries. Examples are the totally enclosed fan-cooled explosion-resisting motor and other electrical items that have promoted the safe use of electricity in areas where volatile hydrocarbons are stored or handled. With such equipment available, safety rarely stands in the way of employing electricity to the maximum extent consistent with economy.

Reliability and continuity of electric service are, of course, desirable for any operation. In oil refining, uninterrupted service is of prime importance, as power outages generally cause serious process upsets and result in operating losses all out of proportion to the duration of the power interruption. The severity of the process upset and time required to get back to normal operating conditions vary greatly with process units and with the duration of the power outage. Even when it is possible to re-establish normal electric service in a matter of seconds or minutes, it may take hours, or more than a day to restore process operations to normal, the amount of time depending on the time lag and other characteristics of the particular process. Where upsets cause products to go off color or otherwise deviate from operating standards, reprocessing costs are incurred in addition to direct production losses. Where the stoppage of flow even for a short time would cause oil to form coke in the tubes of fired heaters, or cause some other undesirable condition, arrangements may be made to provide standby pumping equipment that can be started up immediately, upon loss of the power supply, or if the operation is critical enough to warrant a dual-driven pump, arrangements may be made to pick up the load automatically with the mechanical drive turbine end, when the speed of the pump has dropped to some predetermined value.

Whenever purchased power is used,

The Author

H. M. Stewart is head of the mechanical engineering group at Humble Oil and Refining Company's Baytown, Texas, refinery. A native Texan, he was graduated from Texas A. & M. College in electrical engineering, and has been with Humble for the last 20 years.

*Presented before the Petroleum Electric Power Association, November 19, 1951, 23rd Anniversary, Houston, Texas.

the net reliability of the power supply at the individual process unit and for the refinery as a whole depends on the trouble-free performance of the utility company's system and the refinery power system. Whatever weaknesses there may be in the two systems tend to become additive at the point of utilization, and operations are penalized by the short-comings of both. The refineries have been joint beneficiaries with other industry and the public of the results achieved by utility companies over the years toward improving electric service. Among the steps that have brought about these improvements are high speed switching and relaying, the widespread use of overhead ground wires for shielding major circuits against lightning, and the use of rapid automatic reclosing of circuit breakers to restore service after trip-outs caused by lightning or other transient conditions. These and other improvements have very materially decreased the number and duration of disturbances. We look for further improvements to come as a result of research and engineering ingenuity.

Some of these same measures have been taken to improve the performance of refinery systems. The extent of their applicability varies widely with local conditions. Time delay undervoltage protection has been applied generally to enable motor-driven equipment to operate through momentary surges and outages that otherwise would cause shutdown of equipment.

Where refinery power lines are overhead, studies of operating experience have sometimes indicated where sizable expenditures could be justified to install the best of lightning protective equipment for some of the more important motor-driven services, mainly to prevent outages, and save rewinding expense.

Where a part of the refinery load is generated and the rest purchased, and the utility system and refinery system operate in synchronism, it is of prime importance for the tie facilities to be arranged so the purchased source and the refinery generating source will pull apart by relay action at a predetermined point, on heavy intersystem surges; and for the refinery load to be so apportioned between distribution points that immediately after the systems have pulled apart, each system will be carrying its proper share of the total refinery load—normally about the same as before the systems parted—so that operations may continue uninterrupted or with as little disturbance as possible. To work out the relaying arrangement that will give the best results requires close cooperation between the refinery and the utility company.

An occasional difficult situation may require special consideration and treatment. An outstanding example is a recent instance of a novel application of switchgear for controlling two 3000-hp synchronous motors driving process equipment that required an extraordinary degree of reliability. By incorporating many of the best features of modern control devices into some effective control schemes, it has been possible to operate these across-the-line starting motors so as to meet exacting requirements of the process satisfactorily, despite numerous surges and short outages on the purchased power supply system. This application is regarded as an excellent compromise between the imperfections of the power supply and the demands of the process. The details of this application have been published by the American Institute of Electrical Engineers in Paper No. 50-261 by Horsfall, Thompson, Mills, and Bobo.

As previously said, electricity supplies about 60 per cent of the motive power required by the refining industry. How much further electrification will go, few would be willing to predict. Whatever the rate of increase, it seems certain that electricity will continue to have tough competition with the other forms of energy, the steam turbine, internal combustion engines, and other mechanical drives. The ultimate place of the internal combustion gas turbine cannot be accurately predicted, but it seems certain that it will earn a place of great importance in the power field. Perhaps atomic energy is destined to become a servant of industry sooner than we think. Whatever the shape of things to come, we are confident that as long as we have free enterprise, more and better power will be available in all its forms to meet the needs of the times. * * *

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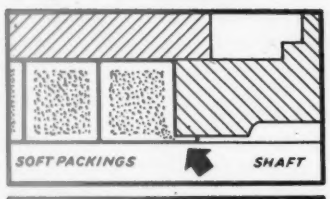

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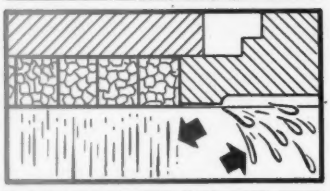
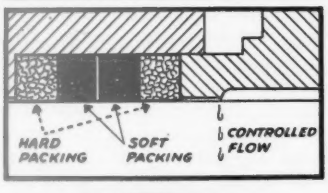


Straight hard packing used throughout often is not sufficiently sensitive to gland pressure to control leakage within the desired limits. Also, the use of this single type of packing may result in scoring the shaft.



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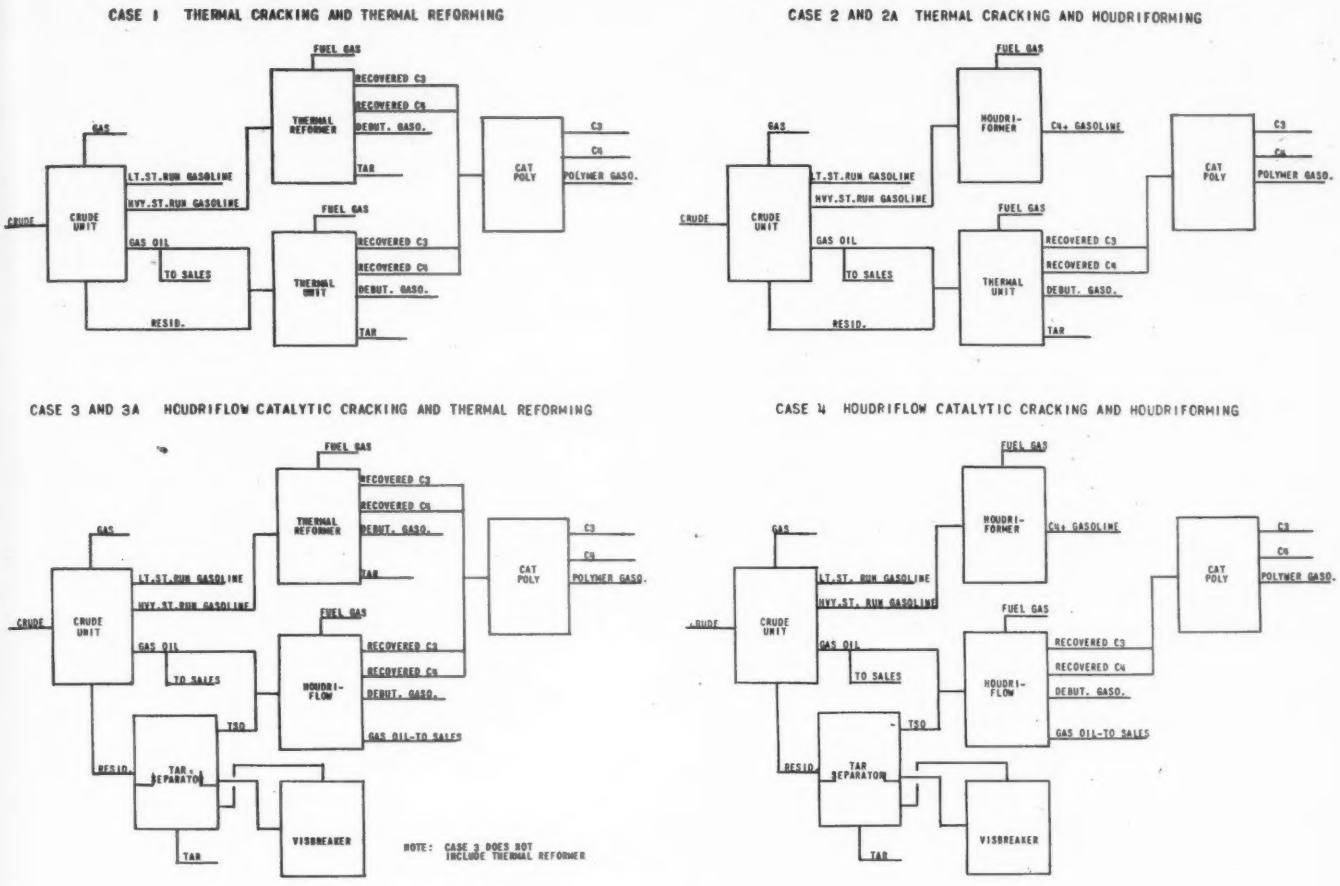

FIG. 1.

HOUDRIFORMING

Its Place in the Refining of Petroleum*

Detailed data show the economics of unit construction and of process operation for several typical cases

T. A. BURTIS† AND H. D. NOLL†

HOUDRIFORMING[1], a catalytic reforming process, has been introduced as an optimum method, as of at present, for improving the octane rating of naphthas, while at the same time, maximizing salable liquid products. Benefits from Houdriforming are not limited to raising the level of octanes and obtaining the maximum octane barrels but also include very considerable aromatics production and very effective sulfur removal. Another advantageous application of Houdriforming is for upgrading natural gasoline or condensate, which at current octane levels have presented a disposal problem to the producers.

A true picture of utilization of catalytic reforming in modern refineries should only be based upon an overall refinery yield and economic study with crude oil charged to the refinery and finished products sold from the refinery. To be realistic, this refinery should contain cracking equipment, either thermal or catalytic, reforming equipment, also either thermal or catalytic, and catalytic

TABLE 1. CRACKING YIELDS.

Charge	Thermal BPCD	Houdriflow BPCD
Distillate	960	960
Residuum	4000	4000
Total	4960	4960
Products		
C_3 and lighter (FOE)	454	444
C_4	290	663
C_5 + gasoline	2155	2510
Fuel oil	2318	1574
Yields applied to cases	1, 2, 2A	3, 3A, 4, 4A

Note: Houdriflow feed preparation consisted of tar separation followed by visbreaking of tar separator bottoms. Houdriflow fresh reactor charge actually 4272 BPCD.

*Presented at the Western Petroleum Refiners Association annual meeting, San Antonio, Texas, April 2, 1952.

†Houdry Process Corporation, Philadelphia, Pennsylvania.

The Authors

H. D. Noll

T. A. Burtis

Theodore A. Burtis, recently appointed as director of development of Houdry Process Corporation, has been associated with the Houdry organization since 1947. Receiving his BS in chemical engineering at Carnegie Institute of Technology and his MS at A. & M. College of Texas, Burtis Joined Houdry after previous engineering experience with Magnolia Petroleum Company and Owens-Corning Fiber Glass Company.

In his previous service with Houdry, he has served as chief of the economics section of the research and development division.

Henry D. Noll has been associated with Houdry Process Corporation for the past 8 years, after 19 years of service with Socony-Vacuum Oil Company, Inc.

As manager of the engineering and technical service division, Noll heads a group of engineers whose function is to aid Houdry licensees in the efficient operation of their refineries, as well as to design new facilities.

Educated at the University of Colorado and the University of Pittsburgh, and holding a degree in petroleum engineering from the latter, he began his career with the Standard Oil Company of New York. Three years later, he was transferred to Magnolia Petroleum Company at Beaumont. In 1938, he joined Socony-Vacuum's research and development laboratories at Paulsboro, New Jersey, where he was placed in charge of both thermal and catalytic cracking.

polymerization. An earlier paper[2] discussed application of Houdriflow catalytic cracking to a 10,000 bbl per calendar day refinery, thereby illustrating various combinations of feed preparation and cracking. Again the starting point for an economic survey is a 10,000 bbl per calendar day refinery. The principal variable studied here is reforming. The yield and economic study presented here considers various methods for processing 10,000 bbl per calendar day of East Texas crude with production of gasoline and other products to arrive at the most profitable methods.

Ultimate products of the refinery include premium and regular gasolines (10 lb RVP), virgin middle distillate, and heavy fuel. Of the total gasoline, 25 per cent is to be premium grade meeting 92 research octane (F-1) and 75 per cent is motor grade, 86 research octane. In cases where the refinery is vapor pressure deficient it is assumed that normal butane, which is readily available, will be purchased.

Thermal cracking, Houdriflow catalytic cracking, thermal reforming and Houdriforming yields are presented hereafter (Tables 1 and 2) based upon Houdry laboratory evaluations of East Texas crude oil. Gasoline and fuel blends from pilot plant operations were prepared and tested.

In the cases presented for economic comparisons, the crude oil is fractionated in a conventional manner with a 250 F End Point straight run gasoline, 250-400 F reforming naphtha, a light cut (400-600 F) for middle distillate uses and a 40 per cent volume residuum. The straight run gasoline is used directly in final motor gasoline blends in all cases. The 250-400 F naphtha is reformed either thermally or by Houdriforming. Of the distillate oil, 1000 bbl per calendar day are assumed as sold with the remaining 960 bbl available as cracking stock. The residuum, 40 per cent on crude, is processed by cracking. Catalytic polymerization is utilized to the extent of the recovered olefins available in the C_8 and C_4 fractions.

Two basic refineries have been considered, one with thermal cracking, the other with Houdriflow recycle catalytic

TABLE 2. REFORMING YIELDS.
Charge to all cases: 1990 BPCD of 250-400 F Naphtha.

	Thermal		Houdriforming		
	Case 1	Case 3A	Case 2 and case 4	Case 2A	Case 4A
C_3 and lighter-wt.%	15.0	8.0	4.3	6.3	2.9
C_4-vol. %	9.1	5.9	4.0	6.8	2.5
C_5 + gasoline-vol.%	73.6	85.0	90.0	86.0	93.0
Polymer-vol.%	3.0	2.0	....	....	....

TABLE 3. YIELDS AND OCTANES.

Case	Total gasoline yield vol. per cent of crude	Research octane + 2cc TEL/gal.	Research octane + 3cc TEL/gal.
1	63.7	85.5	87.2
2	66.4	86.6	88.4
2A	65.0	87.9	89.6
3	72.8	84.8	86.7
3A	69.6	87.9	89.4
4	70.0	91.1	92.4
4A	70.7	90	91.4

TABLE 4. ECONOMIC SUMMARY 10,000 BPCD REFINERY CHARGING EAST TEXAS CRUDE.

Processing		Case 1 Thermal cracking and reforming		Case 2 Thermal cracking Houdriforming		Case 2A Same as Case 2 except more severe Houdriform		Case 3 Recycle Houdriflow catalytic cracking no reforming		Case 3A Recycle Houdriflow catalytic cracking thermal reform		Case 4 Recycle Houdriflow Houdriform (Same as Case 2)		Case 4A Same as Case 4 except less severity of Houdriforming	
Credit	$/bbl	BPCD	$/CD	BPCD	$/CD	BPCD	$/CD	BPCD	$/CD	BPCD	$/CD	BPCD	$/CD	BPCD	$/CD
Premium gasoline	5.04	993	5,005	1,661	8,371	1,626	8,195	750	3,780	1,741	8,774	1,750	8,820	1,769	8,916
Motor gasoline	4.62	5,376	24,837	4,983	23,021	4,878	22,536	6,526	30,150	5,223	24,130	5,250	24,255	5,305	24,509
Straight run gas oil	3.36	1,000	3,360	1,000	3,360	1,000	3,360	1,000	3,360	1,000	3,360	1,000	3,360	1,000	3,360
Fuel oil	1.75	2,378	4,162	2,318	4,057	2,318	4,057	1,574	2,755	1,614	2,825	1,574	2,755	1,574	2,755
Fuel gas (FOE)	0.84	717	602	541	454	580	487	405	340	582	489	547	459	490	412
Total			37,966		39,263		38,635		40,385		39,578		39,649		39,952
Debit															
Crude oil (2.65 + .25)	2.90	10,000	29,000	10,000	29,000	10,000	29,000	10,000	29,000	10,000	29,000	10,000	29,000	10,000	29,000
n-Butane	2.10	239	502	302	634	187	393	70	147	.....	.....	.....	.....	.....	.....
T.E.L. (cents/cc)	0.231		1,854		1,595		1,120		2,118	.....	1,216		458		721
			31,356		31,229		30,513		31,265		30,216		29,458		29,721
Net revenue			6,610		8,034		8,122		9,120		9,362		10,191		10,231
Operating costs															
Operating labor and supervision			378		445		445		378		445		513		513
Operating utility			1,034		907		919		877		1,047		940		940
Chemicals and supplies			154		137		137		141		140		139		139
Catalyst															
Cat poly			39		22		22		43		57		43		43
Houdriformer			....		100		159		....		....		100		100
Houdriflow			....		....		....		260		260		260		260
Royalty															
Cat poly			55		31		31		60		75		60		60
Houdriformer			....		60		60		....		....		60		60
Houdriflow			....		....		....		128		128		128		128
Maintenance			559		585		585		609		636		666		666
Office, laboratory and other overhead			206		206		206		206		206		206		206
Insurance, interest, and taxes			308		373		373		431		494		562		562
Total costs			2,733		2,866		2,937		3,133		3,488		3,677		3,677
Profit before depreciation and tax $/CD			3,877		5,168		5,185		5,987		5,874		6,514		6,554
Investment			$2,250,000		$2,725,000		$2,725,000		$3,050,000		$3,600,000		$4,100,000		$4,100,000
Payout of investment			1.59 Yr.		1.44 Yr.		1.44 Yr.		1.40 Yr.		1.68 Yr.		1.72 Yr.		1.71 Yr.
Cash position in 5 years			$4,825,525		$6,706,600		$6,737,625		$7,876,275		$7,120,050		$7,788,050		$7,861,050

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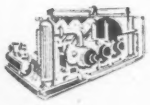
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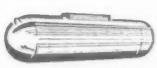
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TABLE 5. VALUATIONS FOR ECONOMICS.

Stocks	
East Texas crude	$2.90/bbl
Premium gasoline (92 F-1)	0.12/gal
Motor gasoline (86 F-1)	0.11/gal
Straight run gas oil	0.08/gal
Fuel oil	1.75/bbl
Fuel gas (FOE)	0.84/bbl
n-butane	0.05/gal
Materials and utilities	
Tetraethyl-Lead	0.00231/cc
Steam	0.30/1000 lb
Electricity	0.008/KWH
Cooling Water	0.005/1000 gal
Treated water	0.10/1000 gal
Catalyst	
Cat Poly	0.30/lb
Houdriflow	0.065/lb
Royalty	
Cat poly	0.21/bbl of Polymer
Houdriflow	0.03/bbl of fresh feed
Houdriformer	0.03/bbl of fresh feed
Miscellaneous	
Operating labor (Average including payroll burdens)	2.815/hour

TABLE 8. MIXED BASE NAPHTHA PROCESSING.

Debutanized gasoline–vol. % of charge	85.2	74.3
Butanes–vol. % of charge	5.8	11.0
Dry gas–wt. % of charge	7.7	14.8
Debutanized gasoline tests		
Gravity–API	44.9	41.6
ASTM Distillation		
5%–F	219	184
50%–F	307	299
90%–F	356	352
CFR research octane		
Clear	84.0	96.9
+ 3cc TEL/gal	94	101.7
Chemical analysis		
Paraffins	45	31
Olefins	2	1
Naphthenes	.....	.....
Aromatics	53	68
10# RVP gasoline yield–vol. % of charge	97.7	83.3
Extraneous n-butane required–vol. % of charge	6.7	.....
Excess butanes–vol. % of charge	.....	2.0
CFR research octane		
Clear	86.4	96.9
+ 3cc TEL/gal	95.5	101.7

TABLE 9. SCURRY NAPHTHA PROCESSING.

Debutanized gasoline–vol. % of charge	87.0	76.4
Butanes–vol. % of charge	4.4	8.6
Dry gas–wt. % of charge	6.2	13.0
Debutanized gasoline tests		
Gravity–API	45.0	41.9
ASTM distillation		
5%–F	210	182
50%–F	276	270
90%–F	360	354
CFR research Octane		
Clear	86.5	96.7
+ 3cc TEL/gal	95.2	101
10# RVP gasoline yield–vol. % of charge	99.9	86.3
Extraneous n-butane required–vol. % of charge	8.5	1.4
Excess butane–vol. % of charge	.....	.....
CFR research octane		
Clear	88.5	97.1
+ 3cc TEL/gal	96.5	101.3

TABLE 6. INVESTMENTS (Process Equipment Only).

Case number	1	2	2A	3	3A	4	4A
Crude unit	500,000	500,000	500,000	500,000	500,000	500,000	500,000
Thermal cracker	900,000	900,000	900,000	.....	.....	.....	.....
Thermal reformer	500,000	.....	.....	.....	500,000	.....	.....
Houdriformer	.....	1,050,000	1,050,000	.....	.....	1,050,000	1,050,000
Houdriflow	.....	.....	.....	2,200,000	2,200,000	2,200,000	2,200,000
Cat Poly	350,000	275,000	275,000	350,000	400,000	350,000	350,000
Total	2,250,000	2,725,000	2,725,000	3,050,000	3,600,000	4,100,000	4,100,000

TABLE 7. NAPHTHA CHARGE STOCKS.

	Mixed base	Scurry	West Texas	California	East Texas
Gravity — API	51.5	52.4	51.7	46.7	52.7
ASTM distillation					
IBP — F	286	220	236	267	238
10%	298	237	266	292	266
50%	312	277	306	323	300
90%	349	361	366	369	358
EP	399	405	391	398	396
Reid vapor pressure	0.5	.....	.....	0.4	0.7
CFR research octane					
Clear	26.4	43.3	38.9	53.3	42.5
+ 3cc TEL/gal	49.7	69.4	60.8	70.6	65.8
Chemical analysis					
Paraffins	44	35	43	19	44
Olefins	1	1	2	0	1
Naphthenes	44	52	42	65	43
Aromatics	11	12	13	16	12

TABLE 10. WEST TEXAS NAPHTHA PROCESSING.

Debutanized gasoline–vol. % of charge	86.4	78.0
Butanes–vol. % of charge	4.6	8.7
Dry gas–wt. % of charge	7.3	12.5
Debutanized gasoline tests		
Gravity–API	45.2	42.0
ASTM distillation		
5%–F	220	202
50%–F	289	283
90%–F	359	357
CFR research octane		
Clear	85.3	95.3
+ 3cc TEL/gal	95.3	101.3
Chemical analysis		
Paraffins	45	31
Olefins	2	1
Naphthenes	0	0
Aromatics	53	65
10# RVP gasoline yield–vol. % of charge	99.3	87.4
Extraneous n- butane required–vol. % of charge	8.3	0.7
Excess butanes–vol. % of charge	.....	.....
CFR research octane		
Clear	87.3	95.6
+ 3cc TEL/gal	96.5	101.5

TABLE 11. CALIFORNIA NAPHTHA PROCESSING.

Debutanized gasoline–vol. % of charge	90.8	83.6
Butanes–vol. % of charge	2.0	5.1
Dry gas–wt. % of charge	5.1	9.6
Debutanized gasoline tests		
Gravity–API	40.3	38.0
ASTM distillation		
5%–F	261	234
50%–F	324	318
90%–F	380	382
CFR research octane		
Clear	85.6	95.2
+ 3cc TEL/gal	94.0	99.5
Chemical analysis		
Paraffins	30	28
Olefins	2	2
Naphthenes	12	3
Aromatics	56	67
10# RVP gasoline yield–vol. % of charge	105.4	96.3
Extraneous n-butane required–vol. % of charge	12.6	7.6
Excess butanes–vol. % of charge	.....	.....
CFR research octane		
Clear	87.7	95.7
+ 3cc TEL/gal	95.7	100.2

cracking. To each refinery is added reforming, either thermal or Houdriforming. Block flow diagrams of the four alternatives are given as Fig. 1. For the two Houdriformer installations, operations at each of two severity levels are considered.

Seven cases are presented on Table 3, Economic Summary. In brief resumé they are as follows:

Case 1—Thermal cracking, thermal reforming and cat poly are the processes used, however, only 15.6 volume per cent of premium gasoline can be produced even with deep reforming and with tetraethyl lead requirement of 3 cc per gallon.

Case 2—Houdriforming operated at moderate conditions is substituted for the thermal reforming of Case 1. The desired gasoline quality can be met with 3 cc of lead in the premium gasoline and 2.3 cc in the motor blend.

Case 2A—Houdriforming to a more severe degree than in Case 2 results in reduction of lead requirements to 1.85 cc per gal for the premium and 1.75 cc per gal for the motor blend.

Case 3—Houdriflow catalytic cracking (feed preparation includes tar separator and visbreaker) in recycle operation supplants the thermal cracker of Case 1. With no reforming, only 10 per cent of the gasoline can be sold as premium because the catalytic gasoline, to bring the low octane straight run naphtha to salable octane levels, must largely be included in the motor blend. 3 cc of lead are needed in each blend.

Case 3A—To the Houdriflow cracking of Case 3, mild thermal reforming (8 wt. per cent C_3 and Lighter) is added. As a result premium and motor blends meet specifications with use of 1.8 cc TEL per gallon.

Case 4—Houdriforming (same severity as used in Case 2) is added to the Houdriflow cracking of Case 3. Lead requirements for premium grade is 0.6 cc per gal while the motor blend uses 0.7 cc per gal. Octanes (F-1) of 94.5, premium, and 89.8, motor, can be obtained with 2 cc TEL per gallon.

Case 4A—A milder Houdriforming operation than in Case 4 results in a slightly greater lead requirement, 1.05 cc per gal for each grade of gasoline. This milder reforming shows to advantage since the lead requirement in Case 4 is so low.

Total gasoline product yield for each case and the research octanes obtained when using 2 or 3 cc per gal of tetraethyl lead are presented in Table 3.

Yields and economics are summarized in Table 4. Material and product valuations assumed for the study are presented in Table 5. Operating and maintenance labor have been estimated based upon typical refinery practice. Maintenance material is considered as 2 per cent of the investment. Interest, insurance, and taxes are assumed to be

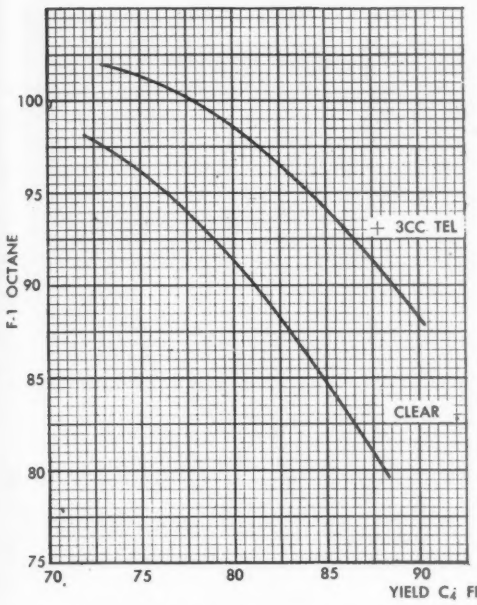


FIG. 2. Yield-octane curves processing mixed base naphtha. 286-399 F 26.4 F-1 clear.

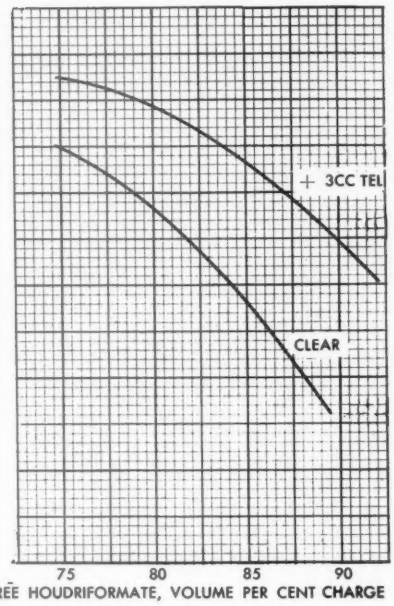


FIG. 3. Yield-octane curves processing West Texas naphtha. 236-391 F 38.9 F-1 clear.

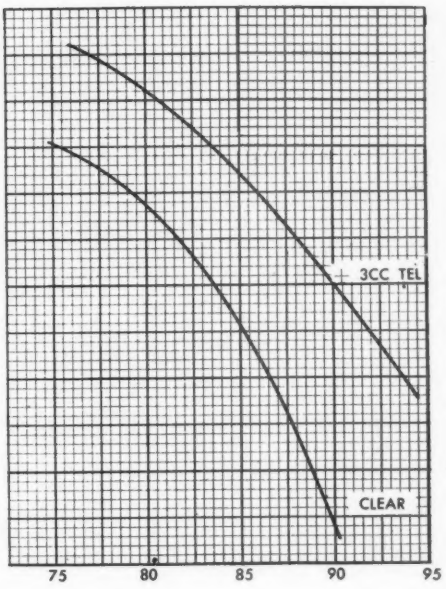


FIG. 4. Yield-octane curves processing scurry naphtha. 220-405 F 43.3 F-1 clear.

5 per cent of the investment. Federal income tax has not been included. Investments shown in Table 6 are for the primary process equipment. Storage and off-site auxiliary facilities are not included, consequently, net earnings are purely comparative.

In the economic summary, Table 4, compare thermal cracking refineries containing, in Case 1, thermal reforming, or in Case 2 and 2A, Houdriforming. If we assume that a Houdriformer be installed new as opposed to a thermal reformer installed new, the differential profits of Case 2 or Case 2A over Case 1, $1,291 and $1,308 per calendar day respectively, will retire the incremental investment, $475,000, in one year and a five year cash position of $1,881,075 or $1,912,000 will be achieved. If, on the other hand, we assume that an existing thermal reformer be replaced by a new Houdriformer and that no credit be allowed for re-use of parts of the old reformer, the differential return, $1,291/CD, will retire the new investment, $1,050,000, in 2.22 years and the cash position in five years is $1,306,075 greater than Case 1.

Compare catalytic cracking refineries, Case 3, 3A, 4, and 4A. The refinery of Case 3 has difficulty meeting the specified octane levels so that some type of reforming is indicated. We can install thermal reforming, Case 3A or Houdriforming Case 4 or 4A. Differential earnings of Case 4 and 4A over 3A are $640 and $680/CD, sufficient to pay off the incremental investment, $500,000, in 2.14 and 2.01 years respectively.

The results shown are by no means limited to East Texas stocks. To illustrate applications of Houdriforming operations to other stocks generally processed by refiners in the USA, data are presented on Houdriforming of five typical naphthas (see Table 7). A mixed base naphtha having a research octane of 26.4 clearly demonstrates what can be done with low octane charge (see Table 8). Scurry naphtha is illustrative of a naphtha from a prolific new crude source and one which many refiners are now processing (see Table 9). Sour West Texas naphtha is an example of a high sulfur stock (see Table 10), a

TABLE 12. EAST TEXAS NAPHTHA PROCESSING

Debutanized gasoline–vol. % of charge	86.5	81.0
Butanes.....–vol. % of charge	5.8	9.0
Dry gas.....–wt. % of charge	6.8	10.5
Debutanized gasoline tests		
Gravity–API	46.0	43.0
ASTM distillation		
5%–F	220	200
50%–F	288	282
90%–F	356	352
CFR research octane		
Clear	87	95
+ 3cc TEL/gal	95.2	100
Chemical analysis		
Paraffins	45	.....
Olefins	2	.....
Naphthenes	2	.....
Aromatics	51	.....
10# RVP gasoline yield–vol. % of charge	98.3	89.5
Extraneous n-butane required–vol. % of charge	6.0	.....
Excess butanes–vol. % of charge	.....	0.5
CFR research octanes		
Clear	88.7	95.5
+ 3cc TEL/gal	96.4	100.2

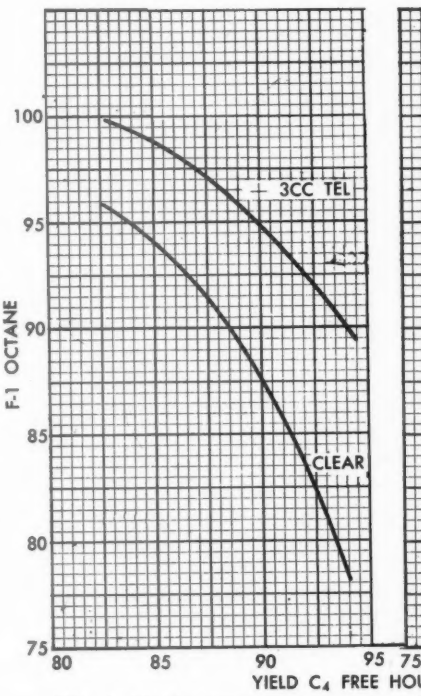


FIG. 5. Yield-octane curves processing California naphtha. 267-398 F 53.3 F-1 clear.

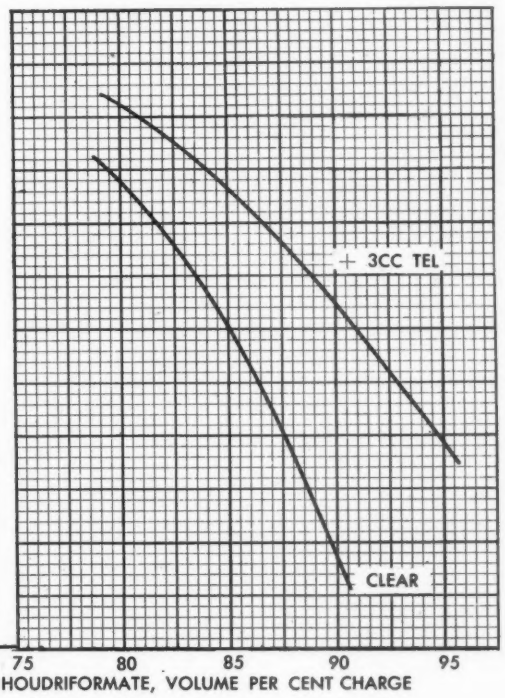


FIG. 6. Yield-octane curves processing East Texas naphtha. 238-396 F 42.5 F-1 clear.

type of stock more and more refiners are processing. California naphtha is illustrative of a high naphthene content charge (see Table 11). Finally, the East Texas naphtha, which was used in the economic study, is illustrated (see Table 12). The yields and tests presented were chosen to show results obtained at 85 and 95 research clear levels. Yield-octane curves for debutanized Houdriformate from each of these stocks are shown as Figs. 2 to 6.

That Houdriforming results in effective desulfurization is demonstrated clearly in Table 13. Houdriformate recovered from operations at several operating severities contained, at most, 3.8 per cent of the sulfur originally present in the charge.

The aromatic content of Houdriformates is a function of the naphthene and aromatic content of the charge stocks, however, some paraffins are converted to aromatics. See Table 10 where the West Texas naphtha processed to 95 octane clear resulted in a net increase in 3 per cent over the theoretical maximum on considering all naphthenes as aromatic formers. The 96.9 research clear case on Table 8 illustrates a similar result.

The adaptability of the Houdriforming process to the production of aromatics is illustrated in Tables 14 and 15. For the results reported on Table 14, the stock charged was a 150-220 F cut with a total naphthene content of 51.2 volume per cent split 18.5 per cent to benzene formers and 32.7 per cent to toluene formers. The total conversion of naphthenes to aromatics was approximately 90 per cent while at the same time, very little destruction of the paraffinic portion of the stock took place. As a result, high purity hydrogen (about 98 per cent) was produced at the rate of 1300 std cu ft per barrel of charge.

Table 15 illustrates the production of C_8 and C_9 aromatics from higher boiling cuts. Here two stocks were processed, one containing 42 per cent naphthene, the other 61 per cent. Again it is evident that the naphthenes can be converted almost quantitatively to the corresponding aromatics. Again, loss of yield other than shrinkage, is low. Note that the aromatic fraction of these products, separated by distillation, gave F-4 + 4.6 cc TEL per gal performance numbers of 190 and 220.

The foregoing presentation shows that Houdriforming is a worthwhile processing tool for:

1. Upgrading low octane heavy naphtha for incorporation in motor fuels.
2. Practically complete desulfurization and octane improvement of high sulfur stocks.
3. Processing of selected cuts for aromatics and/or high rich rating blending fuels.

TABLE 13. SULFUR REMOVAL.

Charge stock: 51.7 API West Texas naphtha (38.9 F-1) sulfur content[1] — 0.23 wt. per cent.

Debutanized houdriformate recovery Vol. %	Sulfur in houdriformate Wt. %	Sulfur removal %
85.0	0.003	98.8
90.4	0.008	96.8
86.4	0.010	96.2
84.5	0.008	97.0

TABLE 14. HOUDRIFORMING A C_6-C_7 FRACTION FOR BENZENE AND TOLUENE PRODUCTION.

Debutanized liquid – vol. % charge	89.3
C_4's – vol. %	2.6
Propane – wt. %	1.1
Ethane – wt. %	0.3
Methane – wt. %	0.2
Hydrogen – wt. %	2.7

Analysis: vol. %	Charge	Debutanized liquid
Benzene	1.4	15.6
Toluene	4.6	31.7
Methylcyclopentane	4.6	2.8
Cyclohexane	13.9	0.8
Dimethylcyclopentanes	9.6	3.0
Methylcyclohexane	23.1	0.3
Olefins	....	0.9
Paraffins	42.8	43.1

TABLE 15. HOUDRIFORMING C_8 FRACTIONS FOR AROMATICS PRODUCTION.

C_8 + liquid, vol. % charge	91.1	87.1
C_4's, vol. %	1.8	3.6
Propane, wt. %	0.9	1.3
Ethane, wt. %	0.4	0.8
Methane, wt. %	0.2	0.8
Hydrogen, wt. %	2.1	2.2

Analysis: vol. %	Charge	C_5 + liquid	Charge	C_5 + liquid
Toluene	....	5.4	....	2.5
C_8 aromatics	1.9	30.3	8.0	40.9
C_9 aromatics	1.1	5.1	....	18.4
Naphthenes	42	2.0	61	2.0
Olefins	....	2.0	....	2.0
Paraffins	55	55.2	31	34.2
F-1 octane number: (Total C_5 + liquid)	....	....	....	94.3
F-4 + 4.6cc TEL aviation blending P. N. (Aromatic Portion)	....	190	....	220

Acknowledgment

The authors wish to acknowledge the assistance of members of the Houdry Laboratories in obtaining the pilot plant data and the work of Mr. D. E. Norris in preparing the economic comparisons.

[1] "Application of Houdriforming to Produce Aromatics and High-Octane Motor Gasoline" Heineman, Schall and Stevenson. Presented before the AICHE So. Tex. Tech. meeting. Galveston, Oct. 19, 1951. *Petroleum Refiner*, November 1951.

[2] "Various Refinery Applications of Houdriflow Catalytic Cracking" G. F. Hornaday, H. D. Noll, C. C. Peavy, W. Weinrich. Presented at WPRA annual meeting at San Antonio, Texas, March 28-30, 1949. *Petroleum Refiner*, June 1949.

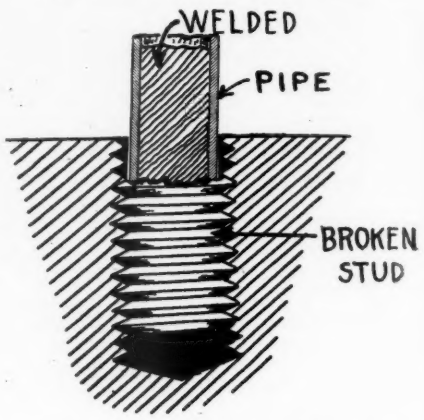
* * *

PLANT AIDS

To Remove Broken Studs

If you are equipped with a welding outfit, or if you are going to get one, here is a kink that will interest you for removing an "un-get-at-able" broken stud.

Get a short piece of pipe that will fit

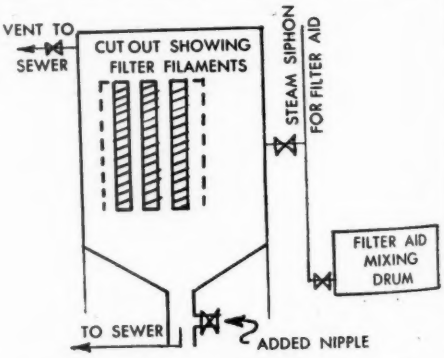


loosely into the opening, as indicated in the sketch. The welding outfit is then used to fill the pipe with enough molten metal so that the pipe will be firmly welded to the stud. The pipe, at the same time, prevents the molten metal from becoming welded to the threads.

Then, when firmly welded, the stud is readily removed by means of a pipe wrench applied to the pipe stub. The removal process is also aided due to the heating of the stud, which expands and thus aids in the loosening of the threads so that the stud can be more easily removed.—W. F. S.

Cleaning Water Filtering Filaments in Situ*

In a water filtering unit the wire-wrapped filaments become fouled, must be cleaned. It is expensive to remove them and clean by hand, also chances



for damage to filaments are great. To clean them in place soda ash, soap and water are mixed in the Filter-Aid mixing drum and siphoned into the filter to clean up the filaments in place. It is necessary only to add a small line and valve (nipple shown at bottom) to the installation. This system saves an appreciable amount annually per filter over other methods.—Wm. Wilkins, Jr.

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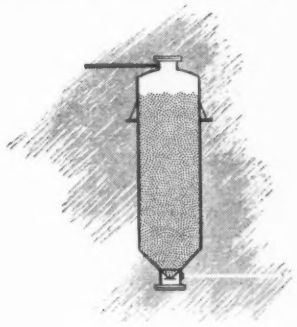

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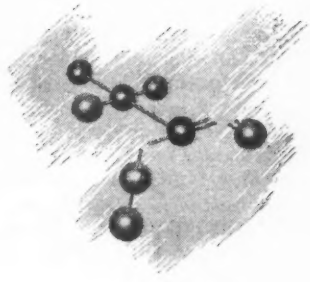

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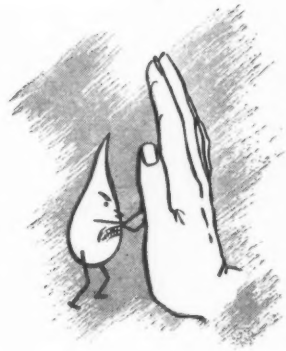

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THE TECHNICAL FORUM

Petroleum Bases

Q **Are any petroleum bases utilized in commercial, or industrial applications at present, either "as is" or as raw materials or intermediates for the preparation of other finished products? If so, can you name a few of these bases, and discuss briefly the chemical processes employed and the final product made from them?**

C. G. N.

A Bases derived from petroleum could be utilized as:

1) Mixtures obtained on fractionation crude bases isolated from petroleum fraction or crude oil.
2) Pure compounds isolated from one of the fractions of (1).
3) Mixtures obtained on treating a fraction mentioned in (1) by some chemical process that would convert the bases into a mixture of a new type of compound.

The patent literature indicates that many proposals have been made to use mixtures such as those mentioned in (1) insecticide solutions or as corrosion inhibitors in pickling steel, acidizing oil wells, etc. In spite of an active search for markets by several California oil companies no important commercial use of this type appears to have been developed.

Although pure compounds can be isolated from fractions of bases isolated from petroleum, the separation problems are so great that production of C. P. compounds appears to be possible only at costs which are prohibitive except for use in the preparation of very expensive compounds such as special dyes or pharmaceuticals. To date no such use of pure compounds from petroleum has been recorded.

Rutherford's patent* illustrates the third possible type of outlet for petroleum bases. He hydrogenates purified bases still representing a mixture of pyridines and quinolines to a mixture of secondary amines which might find use in rubber vulcanization, insecticides, or extreme pressure lubricants. The author knows of no existing commercial use of this type of converted petroleum bases.

H. L. Lochte.

*Rutherford, J. T., U. S. Pat. 2,320,655.

Glycols Synthesis Sources

Q **What are the main sources for raw materials for the synthesis of glycols from petroleum and natural gas hydrocarbons? What are the principal reactions involved in the synthesis, and the main or critical reaction conditions to be maintained—temperatures, pressures, reaction time, space velocities, etc.?**

A Ethylene glycol is the principal glycol of commerce today and is made from ethylene by either the chlorhydrin process or by the direct oxidation process. Ethylene glycol is also made from formaldehyde, obtainable by the oxidation of natural gas, which is converted at 10,000 psi to glycolic acid that is esterified and the esters reduced to glycol. Propylene glycol is made from propylene by the chlorhydrin process. In practice an ethylene-propylene stream is fed to the chlorhydrin process and a mixture of ethylene and propylene glycols obtained from which the propylene glycol may be separated. This discussion is limited to consideration of ethylene glycol made from ethylene by the chlorhydrin and direct oxidation processes.

The ethylene required for glycol manufacture is generally made by the thermal cracking of propane and ethane mixtures obtained from natural gas processing for natural gasoline recovery. Substantial quantities of ethylene are being recovered from refinery gas streams for chemical conversion.

Ethylene glycol was first made industrially by Carbide and Carbon Chemicals Company using the chlorhydrin process they had developed. In this process ethylene, chlorine, and water are fed into a reaction vessel where the chemical reactions indicated below are believed to take place. In a typical case, the ethylene absorber is 50 ft high and 5 ft in diameter and operates at 50 C (122 F). The unreacted ethylene is taken overhead and then passed through an aqueous caustic scrubber to remove acid gases. A portion of the scrubbed gas is vented to purge inerts with the balance being returned to the ethylene feed system where it is mixed with 95 per cent ethylene to give an absorber feed of 70 per cent ethylene. The average chlorhydrin concentration in the absorber is about 4.5 per cent. Dilute (6-8 per cent) ethylene chlorhydrin solution is continuously withdrawn.

The glycol reactions are:

$$Cl_2 + H_2O = HOCl + HCl$$

$C_2H_4 + HOCl = HOC_2H_4Cl$ (ethylene chlorhydrin)

$2HOC_2H_4Cl + Na_2CO_3 + H_2O = 2C_2H_4(OH)_2 + 2NaCl + CO_2$ (glycol formation)

$HOC_2H_4Cl + Ca(OH)_2 = 2C_2H_4O + CaCl_2 + 2H_2O$. (oxide formation)

$C_2H_4O + H_2O = C_2H_4(OH)_2$ (glycol formation)

The side reactions are:

$C_2H_4 + Cl_2 = ClC_2H_4Cl$ (ethylene dichloride)

$ClC_2H_4Cl + Cl_2 = ClC_2H_3Cl_2 + HCl$ (trichlor ethane formation)

$2ClC_2H_4OH + Cl_2 = (ClC_2H_4)_2O + HOCl + HCl$ (dichlorethyl ether formation)

$ClC_2H_4Cl + NaOH = CH_2{:}CHCl + H_2O + NaCl$ (vinyl chloride formation)

The chlorhydrin is reacted with milk of lime containing 10 to 15 per cent CaO in the presence of open steam to liberate gaseous ethylene oxide. This reaction is extremely rapid. The ethylene oxide bubbles up through the tower against a descending alkaline reflux applied at the top of the column to remove entrained ethylene chlorhydrin. The ethylene oxide is then purified by intensive fractionation in 50 tray towers to eliminate the ethylene dichloride-water azeotrope carried over from the preceding tower. The removal of acetaldehyde requires even more elaborate purification but is essential for some uses of the oxide.

The side reactions in this process consume both ethylene and chlorine, the major raw materials. Also the disposal of the by-products so formed offers real but not insuperable problems. The worth offender is ethylene dichloride whose yield is about 5 per cent on the ethylene. A more serious limitation of the process is the matter of chlorine supply. Chlorine is made by the electrolysis of sodium chloride. For every

pound of chlorine liberated 1.1 lb of caustic soda are made. This is in long supply and the production of large quantities of additional chlorine for chemical use, on the average, will only be at higher prices in order to absorb the price penalties which will be necessary to move the caustic soda.

In the direct oxidation process ethylene is oxidized with air or oxygen to ethylene oxide over a silver catalyst at about 260 C (500 F) and moderate pressure. The effluent gas is scrubbed for oxide recovery. As this is a partial conversion process the bulk of the scrubbed gas is mixed with fresh 95 per cent ethylene and air (or 95 per cent oxygen) and recycled to the reactor. The balance is vented to purge inerts from the system. The recovered oxide is further purified for sale as such or reacted with water in the presence of sulfuric acid to form glycol. Basic reactions are

$C_2H_4 + 1/2\ O_2 = C_2H_4O$ (ethylene oxide)

$C_2H_4O + H_2O = C_2H_4(OH)_2$ (glycol)

Chemically this process is much simpler than the chlorhydrin process and with less by-product formation. Both are subject to the formation of minor amounts of diand triethylene glycols in the final distillation of the glycol.

Currently the silver catalyst is used in a fixed bed through which the ethylene-air mixture is passed with oxidation of the ethylene to the oxide and to water and carbon dioxide. The success of this operation rests on the ability to maintain a reasonably uniform catalyst temperature and to avoid hot spots. If overheated the ethylene oxide is further oxidized to water vapor and carbon dioxide. Thus good control of the catalyst temperature is vital. The minimum economic size unit for the fixed bed oxidation process is probably not far from 20,000,000 lb of ethylene oxide per year and may be higher.

In order to improve control of the temperature of the silver oxidation catalyst resort has been made to the fluidized principle so successfully employed in petroleum cracking operations. In this process the finely divided solid catalyst is maintained in suspension in the reacting gas stream. The gas turbulence prevents the formation of localized hot spots with resultant improved temperature control in the reaction zone. This process has been in the development stage for some years and is now reported ready for licensing and industrial use. Doubtless plant use of the fluidized process will lead to its further improvement and economy.—*J. H. Boyd.*

Light Oil Storage Losses

Q What are the comparative evaporation losses, and the economics, of crude storage, crude containing 25 per cent motor fuel, from (a) cone roof vented tanks; (b) floating roof tanks; (c) balloon tanks? Assume air temperatures, composition of lightest components, etc.—M. C. N.

A Cone Roofed Tank. The rate of evaporation of a crude oil containing 25 per cent gasoline depends a great deal on the fractions contained in that gasoline. If there is a large amount of permanent gas in solution in the crude, the rate will be greatly increased. Also, if there is a very high percentage of the most volatile stable fractions, the rate of evaporation is increased.

This shows that there can be a large variation in the rate.

A fair estimate of the yearly loss of such a crude standing in a nearly full, white painted 80M bbl cone roofed tank with low pressure vent valves is from 0.7 to 0.9 per cent of the tank capacity. A very volatile crude as above described could be as high as 1.5 per cent the first year.

As the size of the tank decreases, the percentage loss increases so that when the tank is as small as 5000 bbl the percentage loss will be about double.

The fullness of the tank will change the percentage loss. The greater the outage, the greater the loss.

The color and condition of the paint will change the loss. If the paint is light gray the increase in loss will be slight, a little more for weathered aluminum and about 50 per cent greater for black.

The above is for standing storage.

Pumping loss is another source of evaporation. For this crude apply 0.1 per cent of the barrels pumped out and in. For example if 10,000 bbl is pumped out and in the evaporation loss would be about 10 bbl. It would again be greater for a very volatile crude.

Floating Roofed Tank. The standing loss if the seal is in good condition and has an efficient secondary seal would be about 0.7 bbl per foot of diameter of the tank per year. A very volatile oil might be as high as 1 bbl per foot of diameter per year.

The pumping loss is practically nothing, so that annual throughput is not much of a factor.

Balloon Tanks. By this I presume the tank has a variable volume air-vapor space. These roofs can be designed to stop all of the standing loss. In a single tank installation, practically none of the pumping loss can be saved.

There are tank combinations, however, where the pump out may partly balance the pump in at the same time. Whatever part of the total pumpings thus balanced are saved.

J. H. Wiggins.

Phthalocyanine Pigment Greases

Q What specific advantages are given to greases made with the new non-soap gelling agent, phthalocyanin pigments, which have been announced recently? Are there any disadvantages to the use of these materials that prevent them being practicable for commercial products?—A. L. F.

A The design of some military and civilian equipment has reached a stage where the present lubricating greases available do not prove satisfactory. The problem is primarily one of temperature stability. Soap bodied silicone fluids have been found useful up to about 300 F, but above this point deterioration of the soap has limited the use of such lubricants.

In an attempt to provide lubricating greases that will be usable at higher temperatures (the goal at the minute is at least 480 F) a group at the Naval Research Laboratory[1] have found that lubricating fluids bodied with phthalocyanine pigments, particularly, copper phthalocyanine, will provide lubricating greases that are useful at higher temperatures than are soap bodied lubricants.

As a consequence, tests to date indicate that the high-temperature limit for successful operation of grease-lubricated ball bearings is now set by the chemical and thermal stability of the lubricating fluids available for grease formulation and by the metallurgy of the bearings themselves.

The particular characteristics that make phthalocyanine lubricating greases of value are: They are so resistant to oxidation that they give longer service life at high temperatures and longer storage life for lubricated parts at normal temperatures than do soap products;they are water repellent; they have a tendency to stiffen instead of soften at elevated temperatures; this characteristic, in conjunction with their low bleeding rates, permits formulation with softer consistencies, which in turn results in lower torque at very low temperatures than with soap lubricants containing the same fluid.

Not all copper phthalocyanine pigments are suitable for grease formulation and pigments which are suitable may cost as much as $20 per pound. Introduction into commercial use will probably depend upon experience with such lubricants made in larger amounts. Such products should prove a valuable aid to equipment designers, however, and operators under high temperature conditions.

As the major portion of the lubricating greases used are not subjected to extreme temperatures, phthalocyanine products cannot be expected to replace soap-bodied products.

C. J. B. and R. R. M.

Petro Chemicals in Film

The motion picture and printing industries will soon benefit from a new, tougher photographic film developed by a chemical company. The transparent base for the film is said to be several times tougher than any now in existence, and to retain its original dimensions and properties over a wide range of atmospheric conditions. The new base is chemically related to the synthetic textile fiber, Dacron, which has petroleum derivatives for its two main ingredients. This represents the latest application of petrochemicals in film manufacture.

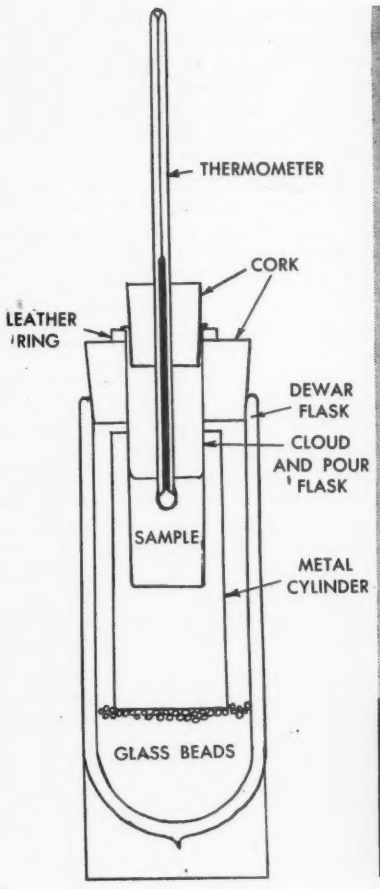
Determination of Cloud And Pour Points

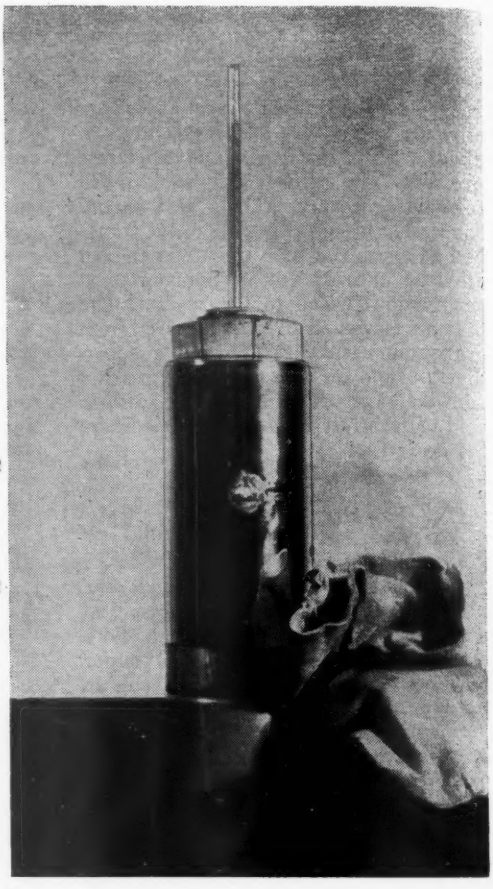
O. M. DUNCAN*

HEREWITH is a sketch and a picture of a simple apparatus for the determination of cloud and pour points. A description of its use follows:

For the small laboratory without a refrigerated pour test cabinet, this apparatus will serve very well for the routine determination of cloud and pour points. Shown is a Dewar flask of about one pint capacity. Glass beads or metal shot are placed in the bottom to permit the metal cylinder to come up about to the top of the flask to serve as an air bath. The Dewar flask is bored so a pour test jar just fits in it. The jar is held in place and kept from touching the cold sides of the metal cylinder by the use of leather rings.

A mixture of dry ice with acetone, gasoline, or light kerosine may be used as the cooling medium to surround the metal cylinder. If cake dry ice is not readily available a substitute may be prepared by permitting liquefied CO_2 to expand through a chamois bag. The rate of cooling can be regulated by occasionally adding small pieces of the dry ice to the mixture.





*Indiana Farm Bureau Cooperative Association, Inc.

Detection of Permanent Anti-Freeze in Used Crankcase Oils

C. D. GREENE*

USED crankcase oils received in this laboratory containing a sludge are often suspected to contain glycol or the decomposition products of glycol type anti-freeze solution. The presence of these being due to the leaking of radiator solution into the cylinders. Experience has shown that the leak may be so slow that heat has decomposed the glycol and very little of the liquid ever reaches the crankcase. This decomposition in contact with the oil on the pistons has resulted in sludge formation and ring sticking. Assuming that a small amount of the glycol does reach the crankcase and is dispersed into the oil the following procedure is considered to be a good method for its detection.

The method used is actually a means of identification of alcoholic hydroxyl groups in alcohols containing up to 10 carbon atoms. Acids, aldehydes, ketones, esters, and hydrocarbons do not interfere.** Alcohols commonly used in temporary type anti-freezes do not interfere as they are removed by evaporation before addition of the test reagent. In the procedure used, positive identification was obtained with prepared oil samples containing as little as 0.5 per cent glycol. An attempt was made to devise a quantitative method using a spectrophotometer but this was unsuccessful because the glycol could not be extracted quantitatively from the oil.

Procedure

To approximately 50 cc of used oil in a 150 cc separatory funnel, add 75 cc of distilled water and shake vigorously for 2 or 3 minutes. Allow to stand for at least 5 minutes. Draw off the aqueous portion into a fluted filter paper, catching the filtrate in a 150 cc beaker. Place 2 glass beads in the beaker and boil to reduce the volume to between 2 cc and 5 cc. Do not boil dry. Allow to cool and add 2 cc of the test reagent observing the addition closely. A change of the solution from yellow to red is an indication of the presence of glycol. If the glycol is present in small amounts or the reagent is strongly acid the red color will fade rapidly due to oxidation, however, a red coloration even for an instant should be considered a positive identification.

Reagent

0.5 M perchlorato-ceric acid in 6 M perchloric acid. This is a commercially available prepared solution. It is a strong oxidizing solution and will cause the color to fade rapidly. Nitrato ammonium cerate in nitric acid solution may be used and is a less strongly oxidizing solution.

*Chemist, Ohio Oil Company.

**"Cerate Oxidimetry," G. Frederick Smith, The G. Frederick Smith Chemical Company, Columbus, Ohio (1942), pp 51-6.

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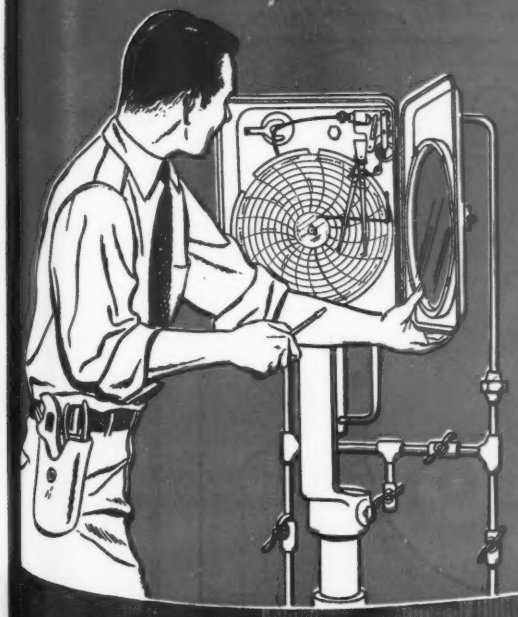

Dependable large volume measurement in field or plant is a certainty when you use Rockwell orifice meters. The recording mechanism is sensitive, rugged, simple and easy to calibrate. It may be removed for inspection without disturbing the meter setting—all the tools you need are a wrench and screw driver. Operating parts are stainless steel to resist corrosion. The Teflon bearing stuffing box always seals tight, never binds, needs no maintenance. An exclusive design feature allows the high side chamber to be interchanged with other chambers of higher or lower range for the utmost flexibility and economy in application.

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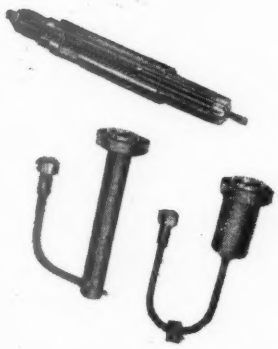

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CFR Cetane Engine Combustion Chamber Volume Measurements

N. F. NICHOL*

THE procedure for combustion chamber volume measurements as specified in the ASTM Manual of Engine Test Methods For Rating Fuels, Section 304, paragraphs (a) through (f), page 122 does not always yield accurate and reliable results. The specified procedure is to make these measurements with the head assembled to the engine. Since it is practically impossible to tilt the whole engine to insure the release of entrapped air, a simple device was made to simulate the overtravel of the piston, that could be attached to the head enabling volume measurements to be made on the bench.

This device was made from a ½-in. steel plate and machined to the dimensions shown in Fig. 1. The sequence of steps taken in machining were:

1. The piston center position and five designated bolt holes were located by laying a head gasket over the plate.
2. The plate was centered in the lathe to the piston center mark.
3. Light clean-up facing cut was taken,
4. With a square cornered tool a 0.015-in. facing cut was taken until a diameter of 3.235 in. remained (this dimension is the piston top diameter—not the cylinder bore).
5. The 5 bolt holes were drilled.

With the device bolted to the head (Figs. 2 and 3) using an old gasket to simulate engine conditions 72 ml of water is introduced into the combustion chamber through the combustion indicator hole. The assembly may now be tilted from side to side and tapped lightly with a hammer to facilitate the release of entrapped air and the hand wheel adjusted to bring the water level to the top face of the combustion indicator hole, when held level on the bench. The handwheel micrometer may now be set to the 2.00 in. specified by ASTM.

Results of measurements made at this laboratory with the use of this device have been found to be much more consistant than those made with the head on the engine and offers the following advantages:

1. It insures the release of all entrapped air.
2. It is very simple to dry the combustion chamber for rechecks.
3. It eliminates the possibility of water entering the piston ring grooves and crankcase.
4. It provides a convenient means of inspecting the valves through the ports for leakage.

We have found that errors as great as 7 ml of water are possible by the ASTM specified method and by eliminating this volume measurement error it may help to reduce the extreme deviations in results encountered with the ASTM D-613 method.

*Supervisor, Engine Laboratory, Richfield Oil.

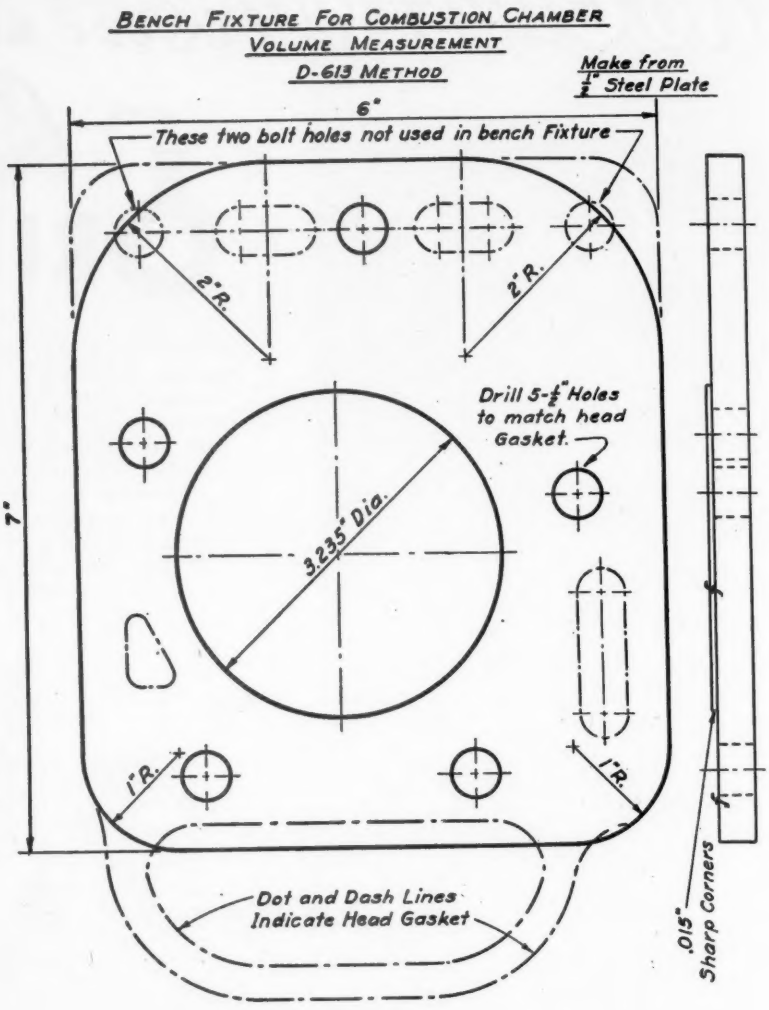


FIG. 1.

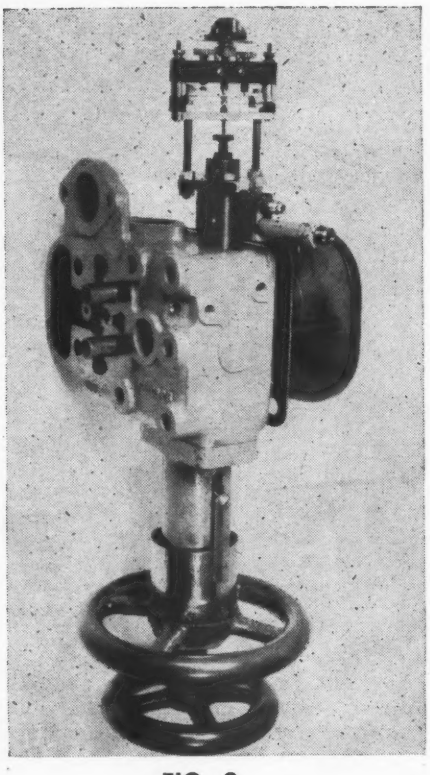


FIG. 2.

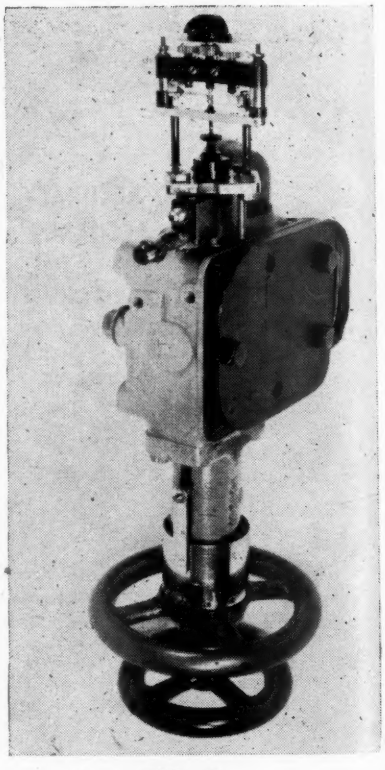
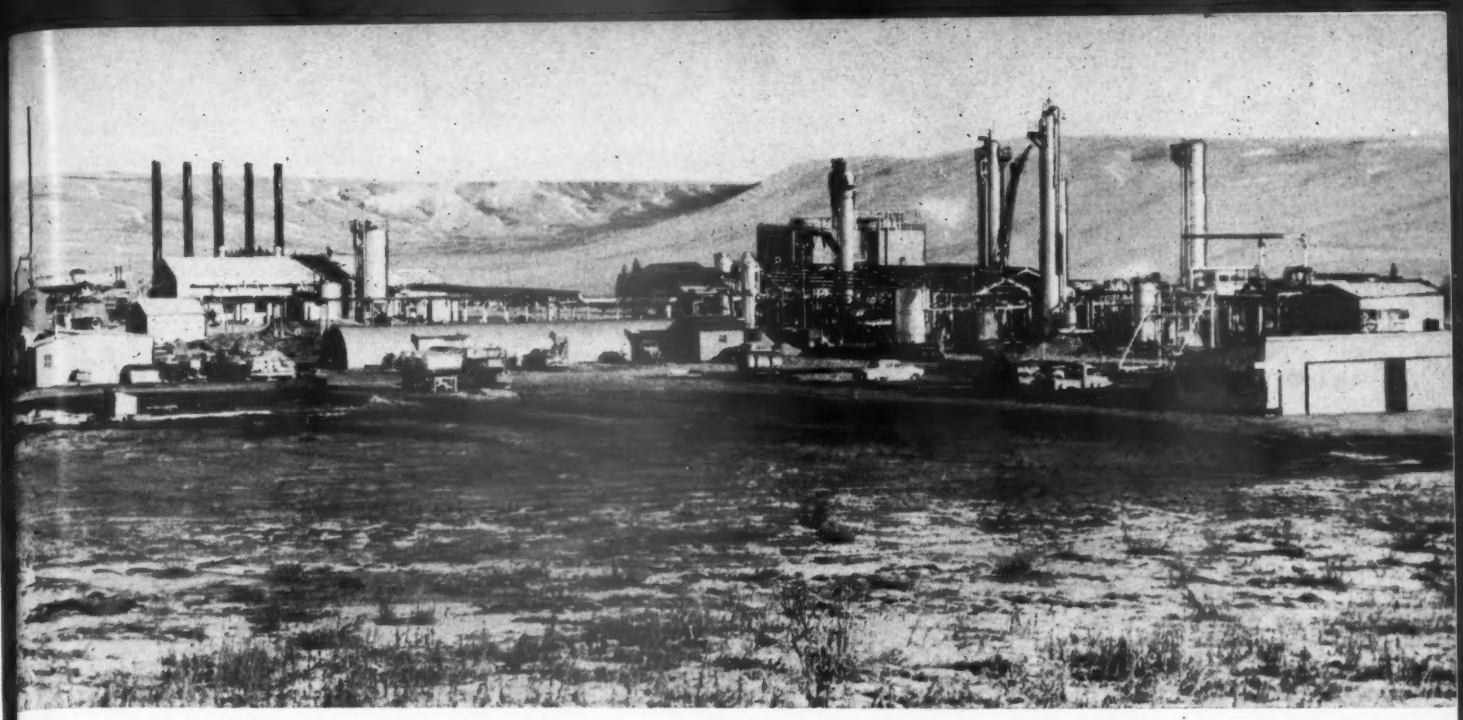


FIG. 3.



Towers of Shell gas processing and sulfur recovery plant at Jumping Pound, Alberta, mark new industrial horizons in northern foothills of province—the range of operations from hydrogen sulfide-bearing feed gas to sulfur pure product outturn here pictured.

P 877.8

Gas for Calgary From Sulfur Recovery

Sulfur conversion unit at Jumping Pound helps to meet Canada's domestic and defense needs in chemical industry

H. C. PLUMMER

PROPER evaluation of future service to Canada's national economy by the sulfur conversion unit at Jumping Pound, Alberta, must rest upon cognizance of the fact that the basic ingredient of the new operation is akin to the yield of Turner Valley's light oil reserves. The geology of the Jumping Pound terrain was first studied and analyzed in 1937 by R. A. Brown, of Calgary, and his associates and established as of "foothills *genre*." They proceeded to assemble leases in the belief, since justified, that Turner Valley was but the initial outcropping and that Jumping Pound might well be the next, as it proved.

The Shell Oil Company of Canada Limited is operator of the plant that will convert the impurities scrubbed from natural gas into pure elemental sulfur, vital requisite of this country's "top industry"—pulp and paper. The sulfur processing at Jumping Pound will be integrated to Shell's new petrochemical manufactory, now under construction, 2159 miles away, at Montreal East. The latter will begin operations by turning out isopropyl alcohol and acetone, in turn utilized to develop many other products of present-day industry.

Petroleum Residues and Wastes Redeemed

Typical of the new era in the Canadian chemical industry is this varied use of petroleum resources — some of them hitherto but residue and allowed to go to waste—to meet the needs of domestic production and, in particular, defense needs. As a result of the diversification of its output and its reduction of our dependence upon imports, the petroleum group has been enabled to contribute to the record chemical production in Canada, now in excess of three quarters of a billion dollars, thus making it one of the fastest-growing segments of the nation's industrial structure. Last year alone approximately $65,000,000 was invested in plant expansion, a large part of it in the petrochemical field, thus setting an all-time "high."

Shell's entry into the Jumping Pound picture was effected in 1941, followed by two years of steady seismic work in the field and long and unremitting study of results, replete with difficulties stemming from the complications of foothills conditions; the first well being drilled in 1942 and continued through 1943. From the information gleaned the conjecture was advanced that the petroleum accumulation might lie farther eastward. Late in 1944 a second well penetrated the Madison limestone, the same productive formation from which the prolific yield of nearby Turner Valley had been obtained. Drillstem tests of the porous section of the Madison brought forth a large volume of gas and some distillate. The well was completed as a producer before 1944's end. It signalized the "staking" of what was to prove one of Canada's bonanza gas fields.

Pipe Line to City-Town Mains, Cement Plant

Early in 1950 an agreement was concluded between Canadian Western Natural Gas Company Limited and Shell providing for deliveries of gas to south-

EXCLUSIVE

ern Alberta. Under that Canadian Western was committed to the building of a pipe line connecting the Jumping Pound field with the city of Calgary mains and Shell, to further drilling of wells, and to construction of a gas plant which would facilitate deliveries of gas. It was planned for Canadian Western later to build a pipe line connecting the field with the Exshaw Cement plant and the town of Banff. The Jumping Pound-Calgary pipe line is now operating. Further wells have been drilled and are under way by Shell and the gas plant has just been completed.

The gas-scrubbing plant, erected by Fluor Corporation of Canada Limited, will process up to 25,000,000 cu ft of gas per day for sale to meet present estimated requirements. A second installation, planned for the future, will bring the plant throughput capacity to 50,000,000 cu ft per day, as the gas demand expands with Alberta's rapid industrial growth.

First of three major component parts of the sulfur-recovery plant, designed to recover 30 long tons per day of sulfur from waste and gases produced by the gas-treating plant, is a hydrogen-sulfide and carbon-dioxide removal unit, where the acid gas feed system originates, available at about 100 F and 5 psig, and having approximately the following composition:

H_2S	33 per cent
CO_2	59 per cent
H_2O	6 per cent
CH_4	2 per cent

Partial combustion follows in a specially designed reactor furnace at the top of which the H_2S bearing feed gas enters; a controlled volume of air being admitted sufficient to convert 1/3 of the total hydrogen-sulfide to sulfur-dioxide and water and all of the hydrocarbons entering the furnace to CO_2 and water. The following equation results:

$$H_2S + 3/2\,O_2 - SO_2 + H_2O$$

Gas Leaves Furnace at 1900 F

A temperature up to about 1900 F may be realized in the gas leaving the furnace; the reaction and the hydrocarbon combustion reactions being highly exothermic. Secondary reactions may occur in the furnace, the direct combustion of H_2S to sulfur by the following reaction:

$$H_2S + \tfrac{1}{2}\,O_2 - H_2O + S$$

and the reaction of sulfur-dioxide with unburned H_2S, as follows:

$$2H_2S + SO_2 = 3S + 2H_2O$$

Catalytic Conversion to Elemental Sulfur

Various sulfur compounds, converted catalytically to elemental sulfur in subsequent stages of the process, may undergo side reactions in the furnace with the hydrocarbons and carbon dioxide to form small amounts of carbon oxysulfide and carbon disulfide.

Combustion gases from the furnace may be cooled to required conversion temperature in the waste-heat boiler with the consequent generation of approximately 7000 lb of steam per hour. Up to 2/3 of the feed gas stream may be by-passed around the furnace and waste-heat boiler. Enough air is provided to burn one-third of the total H_2S to SO_2 and water. Therefore, by-passing results in more complete combustion of the portion that does pass through the furnace and allows some control to be exercised over the temperature and volume of gases entering the boiler from the furnace.

A second by-pass is provided around the boiler to permit the passage of combustion gases from the furnace directly into the first converter, so that the temperature in that unit may be controlled satisfactorily.

Gasoline from Purified Wet Gas

In a gasoline extraction plant a sufficient volume of the heavier hydrocarbons is recovered from the purified wet gas, so as to prevent condensation and deposition of the liquid in the pipe line transmission system.

The combined gas from the boiler and by-pass streams is introduced into the converter, where it passes through the first catalyst bed. Aluminum oxide or natural bauxite catalysts used for this process, have been found to possess high activity and long life. The first bed is operated at a relatively high temperature, in order to eliminate undesirable side reaction products forming in the furnace. A considerable portion of the sulfur is formed in the first catalyst bed, and as the reaction of H_2S and SO_2 is exothermic, the gas temperature increases on passing through the converter; all of the sulfur remaining in vapor state at that point.

Hot gases from the first catalyst bed pass into the boiler feed water economizer, in which they are cooled to the optimum conversion temperature before passing into the second bed. A by-pass around the economizer permits temperature control at that point. The second catalyst bed is operated at approximately 500 F, at which temperature a maximum sulfur conversion is obtained without the deposition of liquid sulfur on the catalyst.

Contacted with Cooled Liquid Sulfur

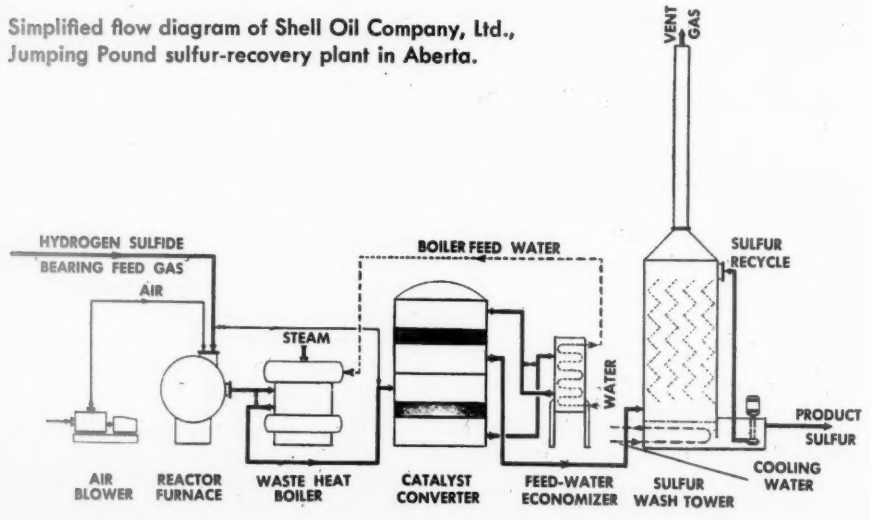
The gases enter the bottom of a sulfur wash tower from the second catalyst bed. There they are contacted with cooled liquid sulfur to condense and cool the product. The liquid sulfur, falling to the bottom of the wash-tower is cooled to approximately 270 F by water in cooling coils. Cooled sulfur is re-cycled over the tower and the excess, the actual sulfur production, is drawn off to storage. The recycled sulfur passes countercurrently to the gas stream and efficiently cools the gas, while acting as a collecting medium for sulfur that condenses.

The vapor pressure of sulfur is extremely slight at the gas outlet temperature; so essentially all of the elemental sulfur vapor is condensed in the tower. The exit gas, vented to the atmosphere, consists primarily of nitrogen, carbon-dioxide, and water vapor, with a negligible amount of unconverted sulfur compounds and the trace of elemental sulfur not collected in the wash-tower. The product sulfur appears as build-up in the sulfur wash-tower. Overflowing, it is transferred by gravity to the sulfur run-down pit. Daily production can be estimated by gaging the sulfur in that pit, which is kept in a molten condition by submerged steam coils.

Removing Water Vapor from Purified Gas

The function of the third stage of the processing facilities, the dehydration plant, is to remove water vapor from the purified gas, to the extent of depressing the dew point to 15 F. Thus the formation of solid hydrates is obviated as is condensation of water vapors in the gas transmission system.

Liquid sulfur from the pit is generally piped to large vats for storage as the solid. The liquid sulfur is distributed in a thin layer atop the sulfur that already has solidified in the vat. When the desired sulfur depth has been reached, the thin sheet metal walls are

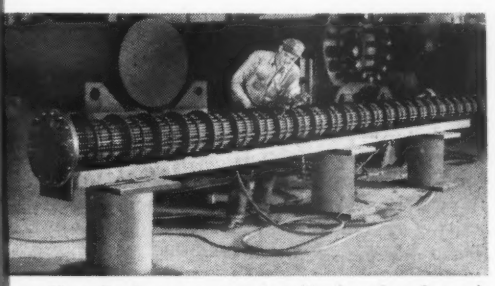


Simplified flow diagram of Shell Oil Company, Ltd., Jumping Pound sulfur-recovery plant in Aberta.

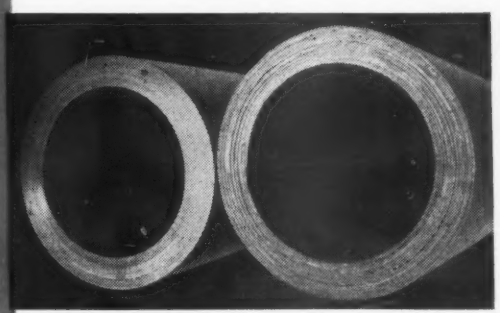
A.O.Smith Multi-Layer Heat Exchangers

Meet the Challenge of High Pressure Specifications

MULTI-LAYER Heat Exchanger for an ammonia plant. The shell, designed for 5150 psi working pressure, is 23 inches and 13¾ inches in diameter with wall thickness of 4¾ inches and 3 inches, respectively.



Heat Exchanger tube bundle for the above is designed to take advantage of low differential operating conditions within an exchanger designed for 5150 psi chemical process.



MULTI-LAYER shell courses showing wall of concentric layers of steel plate. End at right has wrapping completed; at left, machined and scarfed for welding to next course or closure.

Remarkable flexibility of design and manufacture makes A. O. Smith MULTI-LAYER Heat Exchangers adaptable to a wide range of high-pressure services.

MULTI-LAYER Heat Exchanger shells are built up from concentric layers of relatively thin steel plate progressively wrapped, tightened and welded together around an inner pressure-tight cylinder.

Wrapping tension and weld shrinkage develop desirable compression in the inner layers of the shell during manufacture. This results in more equalized loading of all portions of the heat exchanger wall under working pressure. Thus, the full calculated strength of the steel is more completely utilized.

End closures to suit any operating condition are designed by engineers who draw on accumulated A. O. Smith experience in manufacturing more than 6,000 MULTI-LAYER vessels of various types and for pressures up to 10,000 p.s.i.

Where corrosion is a problem, only the inner shell need be made of corrosion-resistant materials. The load-bearing portion of the vessel wall—since it is not in contact with corrodents—can be manufactured of more economical and readily weldable steel plate.

This feature, alone, frequently effects substantial savings over the cost of solid alloy construction and is especially advantageous during the current restrictions on use of certain alloy materials.

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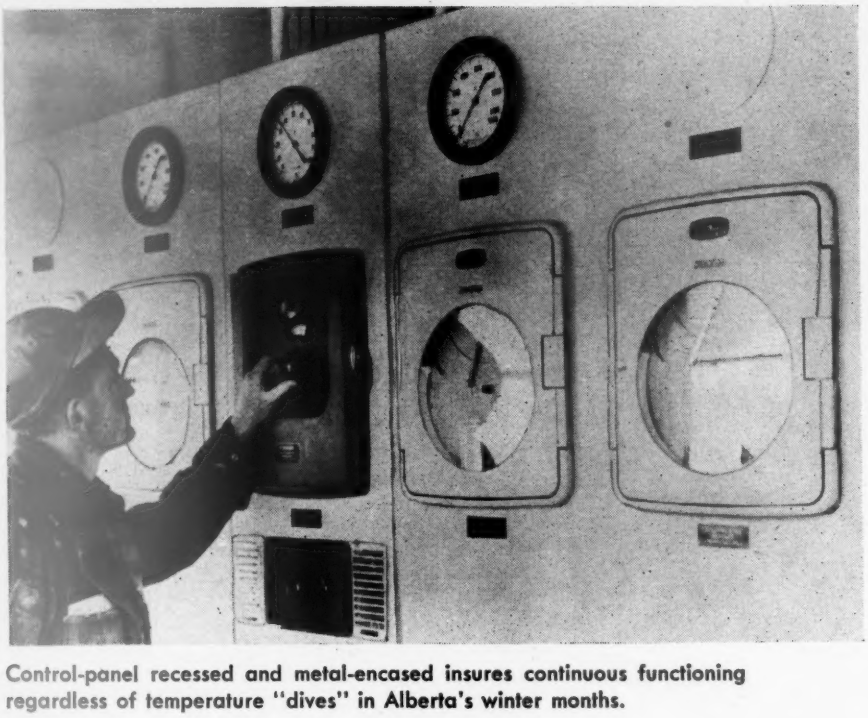


Control-panel recessed and metal-encased insures continuous functioning regardless of temperature "dives" in Alberta's winter months.

stripped off the solid sulfur, leaving a large block of the pure product.

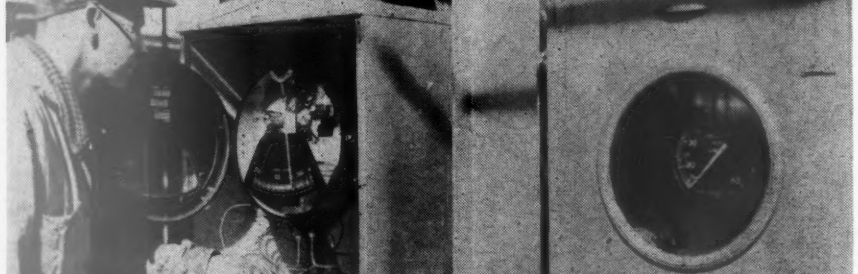
When it is desired to ship bulk sulfur, shot holes are drilled in the block and sulfur is blasted off one face. Because of its friable nature the resulting breakage is normally sufficient for handling. For loading the sulfur on trucks at Jumping Pound the use of a skip-loader is planned. Caution must be exercised in blasting and handling solid sulfur, due to its inflammable nature and the explosive property of sulfur dust in air.

Sulfur Shipped in Molten State

Need for solid sulfur storage and handling facilities at both the producer and consumer terminals is eliminated when sulfur is shipped in the molten state. That procedure, particularly adaptable to plants making sulfur from hydrogen sulfide, if a continuous nearby market for the product is available, has its obvious advantages. Insulated tank-trucks or insulated railroad cars, or in Great Lakes or coastal areas, specially equipped tankers are the usual media. Characteristics of the product and process call for certain definite precautions, however.

The handling of liquid sulfur requires careful control. Its melting point is 239 F, but at 320 it becomes dark brown and notably viscous. It regains its mobility at still higher temperatures. Adequate provision must be made to prevent the solidification of sulfur in any of the lines or vessels and to melt it out, should that occur, by steam-tracing and jacketing and insulating all sulfur lines and providing for auxiliary gas burners to heat the major items of equipment.

Metal-encased delicate precision instruments, which activate processing controls at Jumping Pound natural gas and elemental sulfur producing plant are protected against Alberta's below-zero winter temperatures.



Bring Combustion Furnace Up to Operating Temperature

Following a prolonged shut-down, the auxiliary gas burners are installed through special ports provided for the purpose and used to bring the combustion furnaces and other parts of equipment to operating temperature. If the catalyst beds are not at a sufficiently high temperature when the gases are admitted to the system, deposition of elemental sulfur may occur on the catalyst, greatly reducing its activity and necessitating a prolonged reactivation. Care must be used, also, in designing all sulfur lines to drain completely of sulfur in the event of a shut-down.

Principal control of the process is established by analyzing gas off the final converter. Theoretically the hydrogen sulfide and sulfur dioxide should be present in the gas stream in the ratio of 2 mols H_2S per mol SO_2. In actual practice, however, a slight excess of air is permitted, so that essentially all of the unconverted sulfur leaving the plant will be in the form of the less noxious SO_2. A modified Tetweiler analysis is used for control, in which an initial titration with standard iodine solution indicates the total volume of H_2S plus SO_2 present in the gas, and a subsequent titration of the resulting solution with standard acid gives an indication of the relative quantities of the two acid gases that were present.

Steam generated in the waste heat boiler of the sulfur plant is utilized for powering the air-blower, sulfur pumps and other equipment, and is employed also to provide heat for jacketed liquid sulfur lines and for the rundown pit heating coils.

Product Has Less Ash Than Mined Material

Sulfur produced from hydrogen sulfide by the process described is extremely pure and has considerably less ash than the mined material. Therefore the product can be burned without formation of a crust. Analyses indicate a purity in excess of 99.9 per cent.

Not only will the Jumping Pound plant insure a new source of pure elemental sulfur in the Prairie Provinces, but due to the latest techniques employed by the Fluor Corporation of Canada Limited, its designer and constructor, it will avoid the nuisance of treating-plant acid gas flares.

The elemental sulfur production at Jumping Pound has been contracted for on a long-term basis by Powell River Company Limited, on behalf of that organization and a group of other British Columbia pulp and paper producers. * * *

NEWS

South American Refinery To Get Platforming Unit

Work will begin shortly on the installation of a 5000-bbl-per-day UOP Platforming unit for Compania Espanola de Petroleos, South America. The unit will be constructed at the company's refinery at Santa Cruz, Tenerife in the Canary Islands. This is the 30th Platforming unit to go into design and brings total design capacity of units in operation, or under construction to approximately 115,000 bbl daily.

The CEPSA unit, which is scheduled for completion in late 1953 or early 1954, is being built primarily for motor fuel production. It will operate for seven days per stream month for the production of aromatics, charging a Venezuelan crude stock. During the other 23 days, it will produce motor fuel, charging primarily a Kuwait stock, plus Venezuelan naphthas left from the aromatics operation.

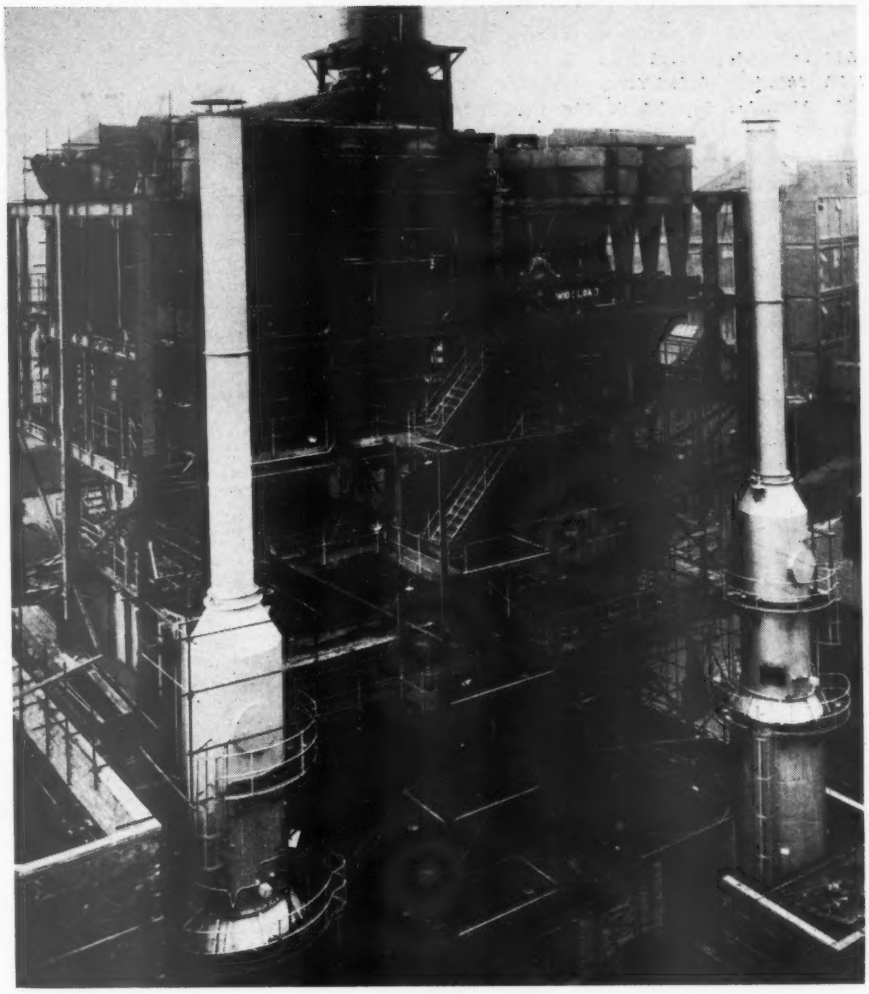
A part of the rich-in-toluene aromatic cuts recovered in the operation will be used as a solvent in lubricating oil production. The rest will be sold as aromatic solvent for general purposes as well as for other industrial uses. Further Udex treating of these cuts to produce nitration grades is being contemplated. Design of the CEPSA Platforming unit will be by Universal Oil Products Company and construction will be handled by Procon, Inc.

Lion Chemical Plant Set

Lion Oil Company has announced plans to build a new chemical plant at an estimated cost of $31,000,000. The new plant will be designated as the Barton plant and will be situated at Luling, Louisiana, approximately 14 miles north of New Orleans on the Mississippi River. The plant will have a capacity for the daily production of 300 tons of anhydrous ammonia, the greater part of which will be converted into prilled ammonium nitrate. Natural gas for raw material and fuel will be supplied by The Texas Company from its production in the immediate area in Louisiana. The company has received a certificate from the Defense Production Administration permitting, for the purpose of Federal income taxes, amortization of approximately 50 per cent of the cost of the new plant over a period of five years.

Eagle Oil Offices Moved

Eagle Oil and Refining Company, Inc., and Sunset Oil Company and their affiliated companies have announced the removal of their general offices to the 8th floor of the Tishman Building, 3450 Wilshire Boulevard, Los Angeles. Affiliated companies include: Arroyo Self Service, Inc., Colorado Self Service, Inc., Mission Oil, Padre Oil, Real Oil Companies, and Santa Ana Self Service, Inc., and Sunset Stations, Inc.



View of spray dryers of new petroleum catalyst plant constructed at Warrington, England, by Joseph Crosfield and Sons, Ltd., an affiliate of Lever Brothers and Unilever, Ltd., under the technical direction of The Davison Chemical Corporation, Baltimore. Note dust collectors at top.

Oxo Alcohol Plant Planned

Standard Oil Company (Indiana) has announced its plans to construct a large iso-octyl alcohol plant at its Wood River (Illinois) refinery. The plant is divided into three basic parts: A fractionation system for obtaining heptene as a "heart cut" from an olefin feed stock; a refinery gas reformer for preparation of hydrogen and carbon monoxide; and finally, the actual iso-octyl alcohol section where the heptene, hydrogen and carbon monoxide are synthesized into the end product. Process design for the last-named unit will be Standard's. The other two sections will be M. W. Kellogg Company, contractors, designs.

English Plant Reaches Catalysts Output Capacity

Davison Chemical Corporation has announced that full scale production of petroleum cracking catalysts has been reached in the plant built by Joseph Crosfield and Sons, Ltd., Warrington, England, using the Davison processes.

The plant is expected to produce at the rate of more than 10,000 short tons of catalyst a year, sufficient to process about 90,000,000 bbl of petroleum, based on average refinery use of cracking catalyst.

The development was brought about through agreements with Davison and with five important oil companies, which will use the catalysts in their refinery operations—Esso Petroleum Company, Ltd., Anglo-Iranian Oil Company, Ltd., Shell Refining and Marketing Company, Ltd., Trinidad Leaseholds, Ltd., and Bahrein Petroleum Company, Ltd.

The Davison process for producing the microspheroidal type of synthetic fluid silica-alumina petroleum cracking catalyst is employed at the plant. Part of the equipment used is two Swenson Evaporator Company stainless steel dryers.

Carbon Black Output Up

Production of carbon black in the United States in 1951 totaled 1,677,363 thousand pounds, 21 per cent above 1950. Total sales increased 4 per cent to 1,563,138 thousand pounds. Producers' stocks increased 113,691 thousand pounds to 203,234 thousand pounds. Production of furnace blacks increased 35 per cent.

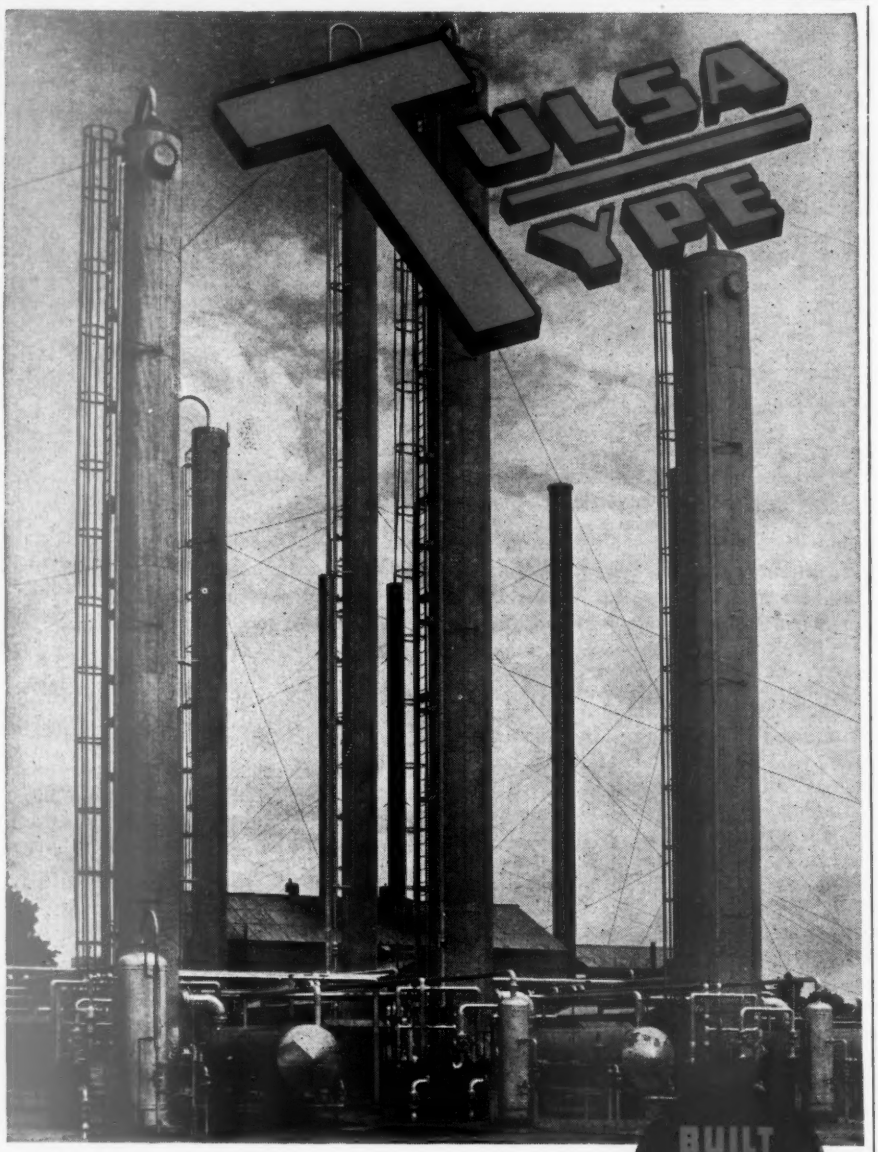
Pakistan Refinery Planned

A three-man mission of refinery and marine experts were in Karachi, Pakistan, recently to examine and report on the technical aspects of the proposed installation of an oil refinery in Karachi, with special reference to selection of a suitable site.

The three experts are Captain S. C. C. Thomson, J. Handerson and R. Cook. Government officials to be associated with these experts of the Burmah Oil Company are Z. H. Khan, chairman, Karachi Port Trust, Hadi Hasan, joint secretary, and M. Siddiqui, deputy secretary of the Ministry of Industries. Burmah Oil Company, Ltd., offered to erect an oil refinery at Karachi in March this year, as a result of talks between the Government of Pakistan and W. E. V. Abraham, managing director of the company.

Shell Buys Hyman Stock

Shell Chemical Corporation has completed arrangements for the purchase of the stock of Julius Hyman and Company, manufacturer of the insecticides aldrin and dieldrin, it was announced by Jan Oostermeyer, president. The Denver, Colorado, firm will continue in business under its present name. Oostermeyer also stated that Shell has completed negotiations with the Velsicol Corporation of Chicago for exclusive rights to the two insecticides.



TULSA TYPE Deethanizer, Depropanizer and Debutanizer Columns in natural gasoline plant.

FLINT STEEL CORPORATION
TULSA, OKLAHOMA

U.S. B. of M. Awards Contract For New Oil-Shale Units

J. H. East, Jr., regional director of the Bureau of Mines, has announced the award of a $288,980 contract to the Blaw-Knox Construction Company of Pittsburgh, Pennsylvania, for the construction and installation of a new pilot plant retort and two oil-shale storage and distribution systems at Rifle, Colorado. As signed by the contracting officer, Boyd Guthrie, chief of the Bureau's Oil-Shale Demonstration Branch, the three-part contract provides for (1) gas-combustion pilot plant No. 2, costing $107,920, (2) a $79,470 raw shale storage and distribution system to serve all pilot-plant retorting facilities, and (3) a $101,590 raw shale storage and distribution system for a demonstration-scale retort now under construction by the same firm.

Meanwhile, construction of the large demonstration-scale retort, which has a capacity range of from 150 to 300 tons of oil shale daily, is proceeding on schedule, Guthrie reported. The initial test run probably will be made late this summer or in early fall.

Major objectives of the demonstration retort, Guthrie said, are (1) to determine cost and yield data that will permit an accurate evaluation of the gas-combustion retorting process; (2) to provide the technical information that industry needs to design commercial plants; and (3) to supply crude shale oil in the quantities required for the Bureau's refining studies.

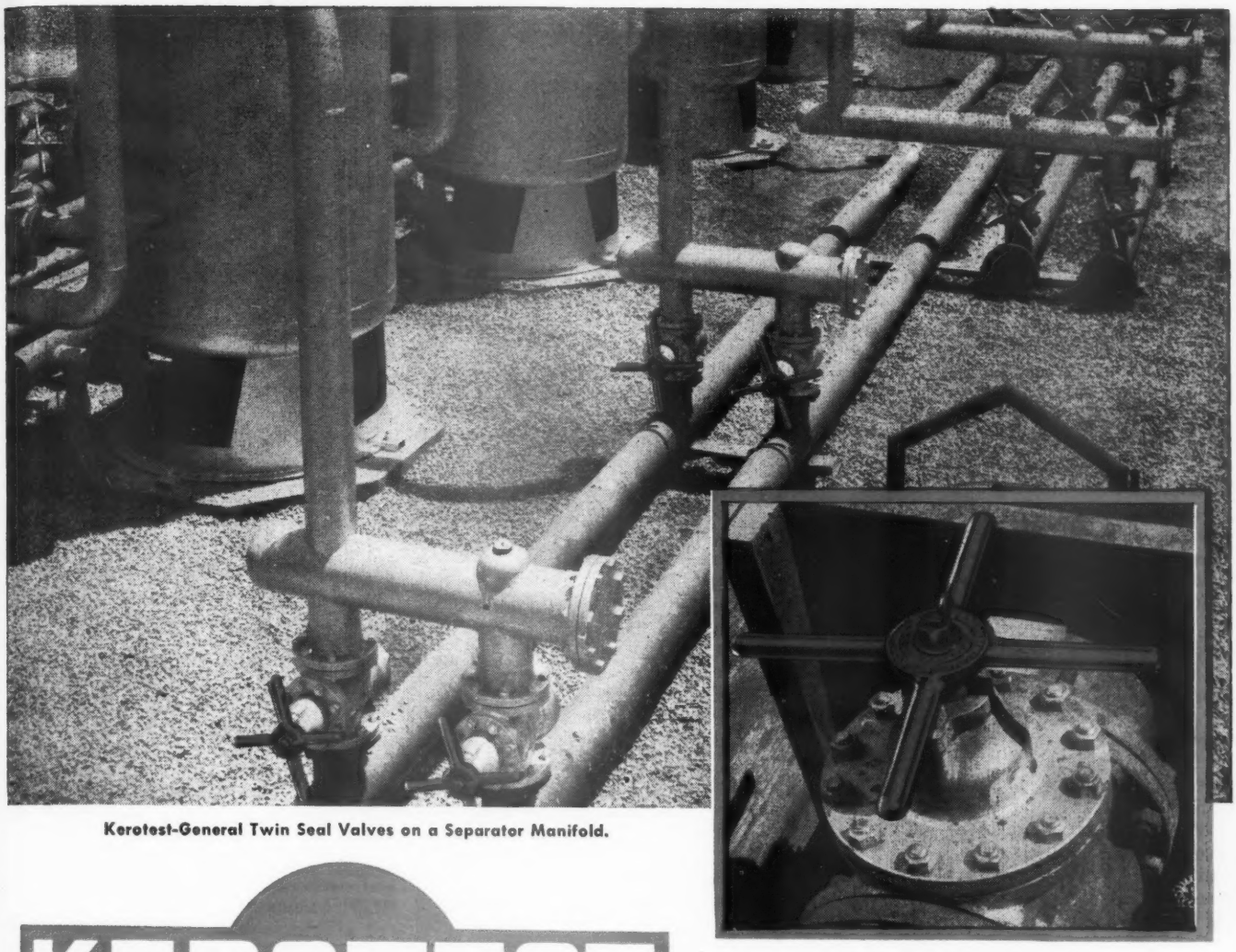
Chemicals Plant Announced

American Cyanamid Company will build a plant near New Orleans, Louisiana, for the production of chemicals from natural gas, it was announced by K. C. Towe, the company's president. The new plant for which a Certificate of Necessity was recently issued by the government, will represent an investment of about $50,000,000 and will be situated on a 600-acre site in Jefferson Parish, Louisiana, about 10 miles above New Orleans on the west bank of the Mississippi River.

As initially projected, the plant will produce ammonia, acetylene, hydrocyanic acid, and derivatives of these products, among them acrylonitrile and ammonium sulfate. Chemical Construction Corporation, a subsidiary of American Cyanamid Company, is the architect-engineer and construction manager of the plant. Construction sub-contract has been awarded J. A. Jones Construction Company, Charlotte, North Carolina.

Oil Black Division Set Up

Witco Chemical Company has organized an Oil Black division which includes the Continental Carbon Company plant in Sunray, Texas, and the Continental Oil Black plant in Westlake, Louisiana. J. H. Wishnick and R. A. Reinke have been appointed manager and general superintendent respectively of the new division.



Kerotest-General Twin Seal Valves on a Separator Manifold.

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NON-LUBRICATED TWIN SEAL VALVES

- ✓Shuts off Vapor-Tight
- ✓Easy to Operate
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- ✓No Scoring or Galling

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GASOLINE	LIQUID NITROGEN
LIQUID OXYGEN	CARBON DIOXIDE
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New Processes and Products Hold Attention of API Refiners

The tremendous advances in refining technology during the last ten years and more paraded in imposing numbers before the assembled members of the refining division, American Petroleum Institute, in San Francisco, May 12-15, 1952. Hampered by the critical refining workers' strike then gripping the industry east of the Pacific Coast, the attendance of more than 800 technologists and executive leaders was only slightly less than was anticipated; the full program was carried out to the absorbing interest and advantage of all who attended the sessions.

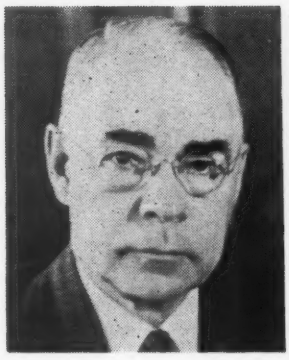
Looking directly to the mounting list of problems and the rapidly increasing demands of both military and commercial-industrial consumers of petroleum products, these consumers and the producers who meet the requirements have worked in collaboration to find out what constitutes better products and methods and means of making them by present known processes. Production and recovery of aromatics from petroleum fractions and the endproducts from new processes was one of the largest subjects discussed at great length, in the light of processes to accomplish these results, yields obtained, and the quality of products made. The increasingly close liaison between the military forces and their suppliers is indicated gratifyingly by the report of results obtained by gruelling tests on ordnance fuel requirements and performances as carried out in the arid western areas by autotechnologist Gilbert Way and his "Desert Rats" engineers who did the job.

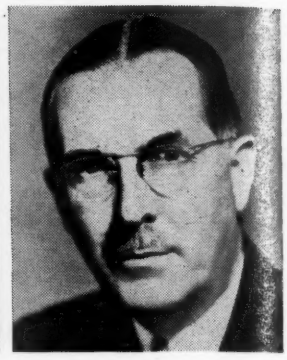
Corrosion is an enemy whose ranks are being expanded all through the industry. A battery of five papers discussed in detail the effects of and means for fighting corrosion, in storage tanks, process units, along with methods for keeping tab on corrosion as a systematic routine linked with safety measures.

The increasingly insistent demands on electric power and the technical and operating problems that accompany this phase of refinery operation also came in for two full sessions and much discussion. Probably the most crowded meetings were the two on May 12, devoted to 15 papers on all phases of analytical problems and analytical research in this field. "You can't know what you're making, or how much, unless you can analyze the product stream," appeared to be the theme of this discussion.

Smith, Pew Receive Certificates

The most dependable way to avoid Federal subsidies and to prevent bureaucratic control of research is for Americans and American industries to continue to support higher education, said Cal Tech's president, Dr. L. A. DuBridge, in addressing the refining division's annual banquet meeting. Dr. DuBridge gave his stimulating address on the occasion of the award by the API of certificates of merit to Standard of New Jersey's vice president, Chester F. Smith—ex-vice president of the refining division—and J. Howard Pew, former president and still director of Sun Oil Company. This award is made to members of the industry as recognition for outstanding contributions to the activities and advancement of the industry. Pew took over the presidency of the Sun company from his father in 1912, and has sparked many activities of the industry under API direction, is a trustee of Grove City College, Pennsylvania, from which he graduated before completing his formal education at Massachusetts Institute of Technology. Chester F. Smith graduated from the University of Pennsylvania, worked summers for New Jersey company, then began his climb from Bayonne refinery laboratory in 1913. He was made president of the Delaware company of the Standard Oil family in 1940, director in the Jersey company in 1944, vice president of refining in 1946. In discussing the educational field from which the leaders of the future for oil refining and all other major activities of the country must be drawn, Dr. DuBridge emphasized that Federal grants (subsidies) to education must be "avoided"; only thus, said the educational leader, can we sidestep centralized bureaucratic control and direction of teaching and of research. A grant of funds to subsidize education, by the Federal government presupposes Federal control of its spending, he implied.





J. Howard Pew, former president of Sun Oil, and Chester F. Smith, vice president of Jersey Standard, were awarded API Certificates of Merit at California meeting.

Editor's Note: A full summarized report of technical details of the meeting will appear in next month's issue of *Refining and Gas Processing*.

"Choice and Maintenance of Instruments" Series Starts in July Issue

In next month's issue of Refining and Gas Processing, *The Petroleum Engineer* publishes the first of an extended group of articles discussing in the most practical detail the selection and maintenance of every type of control, recording, indicating instrument employed in the refinery, natural gasoline plant, and petrochemical plant. This series of articles will discuss:

1. Modern thinking regarding instruments and the instrument department, repair shops, and personnel, and the development of repair departments.
2. Principles governing the selection of instruments, advantages, and disadvantages of the different types of instruments, their applications and their limitations.
3. Exhaustive details of repair methods, inspection, and test check routines for each type and kind of instrument employed, articles that will form the most complete maintenance manual yet available to the industry.
4. Studies of the instrumentation needs of each type of unit in the modern refinery, instrument panels and their design, assembly, principles governing panel design, and their simplification.

This series will concentrate on instruments and what the user, the operator, and the maintenance personnel must know about them to improve operations and instrument efficiency. Attention will be given to design principles largely to aid the reader to understand better the selection and maintenance requirements of all sorts of instruments for the petroleum and gas industries, rather than to make instrument designers of our readers. Emphasis will be placed always on the practical, the operational problems to make the articles of primary usefulness to the men who direct and operate manufacturing plants.

Beginning now with this series the reader will have eventually the entire manual available, the latest word on this increasingly important field, articles prepared by outstanding authorities in instrumentation.

The Editor.

Imperial to Enlarge Its Canadian Oil Refinery

Imperial Oil, Ltd., has announced plans for a $13,500,000 construction program at its Ioco, Canada refinery. R. W. Dunlop, manager of the engineering division of Imperial's manufacturing department, said that ground preparation and preliminary engineering work will start immediately. Erection of the new equipment will begin early in the fall, and it is expected that the work will be completed by fall of 1953.

The expansion program will raise the refinery capacity from its present 12,000 bbl a day to 22,500 bbl a day. The enlarged refinery will process crude oil brought from Alberta by the Trans Mountain pipe line.

A fluid catalytic cracking unit with a capacity of 7600 bbl a day is part of the construction program. With a "cat cracker", gasoline of higher quality can be obtained from crude oil.

Contract for the major portion of the construction has been let to Canadian Bechtel, Ltd.

File-to-Field Service On Platforming Units

Carl B. Whyte, executive vice president of Procon, Inc., has just announced that the company is ready to provide file-to-field construction service on Standard A, B, and C Platforming units of 600, 1000, and 1500-bbl per day design capacities from drawings already in the company's engineering files. Actual capacities of these Standard Platforming units will vary according to feed stocks and method of operation, but the range of sizes permits the selection of a capacity best suited to the individual refiner.

Install Plant for New Ammonia Process

A new process for production of ammonia from natural gas and air is being installed in a new plant building for Spencer Chemical Company at Vicksburg, Mississippi, the cost of production of which is at least six per cent lower than other processes, its manufacturers claim. It was developed by Air Products, Inc., Allentown, Pennsylvania. The new unit will produce 200 tons daily of ammonia from natural gas available from pipe lines at Vicksburg at high pressures.

Key equipment will be installed at a cost of more than $1,000,000, to recover 180 tons of oxygen and 310 tons of nitrogen from the air. Natural gas is burned with the oxygen, releasing hydrogen that is combined with the nitrogen to form NH_3. This process uses the same general principles, but differs from older processes in separating oxygen and nitrogen in air before partial combustion of the gas. The gas lines cross the river at Vicksburg, which is an important factor in the decision to locate the new unit at that point.

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in all forms—ranges—stem lengths—connections

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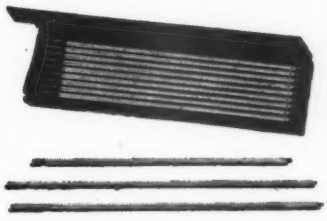
—have readable, dial-type scales and corrosion-resisting stainless steel stems—stem lengths from 2" to 24"—ranges from low as −100°F. to high as 1000°F.—accuracy ½ of 1% of thermometer range.



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—certified sets of ASTM Testing thermometers with overlapping ranges in protective case. Ranges from −36°F. to high as 760°F. Also precision and standard etched stem thermometers for general testing.

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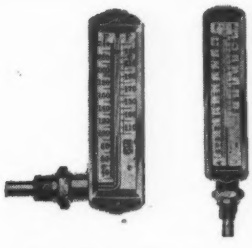
—provide unmatched readability and durability—accuracy within 1% of thermometer range. Available in all types, ranges and stem lengths (2½" to 72") for all requirements.



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—available in all forms, all ranges, stem lengths and connections. Accuracy within one scale division. Also submarine types, metal and cupcase thermometers.

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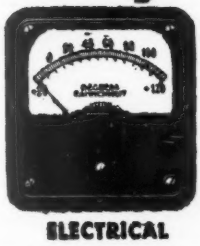

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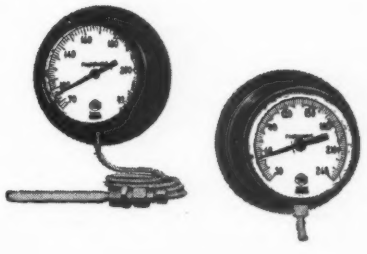

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WESTON Temperature Instruments

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9413

PERSONALS

M. H. Keel

M. H. Keel has been appointed manager of a newly formed advertising department in Shell Chemical Corporation. A graduate of the University of Alberta (BSc) and of the University of Michigan (MS), Keel joined the advertising staff of Shell Chemical Corporation in 1948. He brings to his new position six years of research and operating experience in the chemical and petroleum fields and six years of advertising.

John W. Newton of Beaumont, Texas, vice president and manager of Magnolia Petroleum Company's refining division, was honored recently by the Exchange Club of Beaumont as the twelfth annual recipient of the Club's Golden Deeds Award. The award is given each year for a citizen's outstanding contributions to the community and in recognition of public service. Newton has been associated with nearly every civic project that has taken place in the Beaumont area the past 25 years.

Newton was graduated from Texas A. & M. College in 1912 with a degree in chemical engineering. After two years as an instructor there, he joined Magnolia as a chemist in the Beaumont refinery in 1914. Three years later he was appointed chief chemist and in 1919 was made assistant manager of refineries and the next year was appointed manager of the refining division. In 1938 Newton was elected a director and a vice president of Magnolia Petroleum Company.

Ben F. Hartman, assistant manager of the process promotion division, Socony-Vacuum Laboratories, Socony-Vacuum Oil Company, Inc., New York, has been named technical director for the company's Augusta, Kansas, refinery. Hartman will fill the position of the late Emory Skinner.

A native of Beloit, Kansas, Hartman was graduated from Kansas State College in 1930 with a BS in chemical engineering. He joined Socony-Vacuum as a chemical engineer in 1937.

John M. Graham has been appointed chief process engineer in Standard-Vacuum Oil Company's refining coordination department. He resigned his position as assistant supervising engineer in the Standard Oil Development Company's Esso engineering department to accept the Stanvac appointment. A mechanical engineering graduate of Massachusetts Institute of Technology in 1932, Graham received his master's degree in chemical engineering at MIT the following year.

After two years' service with Calco Chemical Company he joined Standard Oil Development Company. He has been assistant supervising engineer of the Esso engineering department for the last two and a half years.

C. E. Spearing has been named general manager of Anglo-Iranian Oil Company's refineries department. Due to the rapid growth of Anglo-Iranian's interests outside Persia, the company's refineries department has been split into six divisions. **M. A. L. Banks** will serve as deputy to Spearing.

The divisions, each with its manager, consist of a research and development division, an engineering division, and four regional divisions covering the Middle East, Continental, United Kingdom, and the Australian refineries.

D. G. Smith is in charge of the research and development department, which is concerned with the company's research station at Sunbury, as well as all other matters relating to patents, trademarks, and process development.

R. C. Thomson is manager of the engineering division. He is responsible for the execution of projects and for providing the regional divisions with engineering services.

H. W. Rigden has been appointed manager of the United Kingdom division, which covers the Llandarcy, and Grangemouth refineries, the Kent refinery now being built, and the British chemicals plant at Grangemouth.

S. W. Adey is manager of the Middle East division, which includes refining interests in Iraq and other areas and, in addition, the new refinery project at Aden. The Australian division covers the new Kwinana refinery project and is managed by **D. W. K. Barker.**

Pending appointment of a manager for the Continental division, work of the division is being co-ordinated by **O. A. Bell** (manufacturing) and **C. Billingsley** (projects) under the general direction of Banks, the deputy general manager of the department.

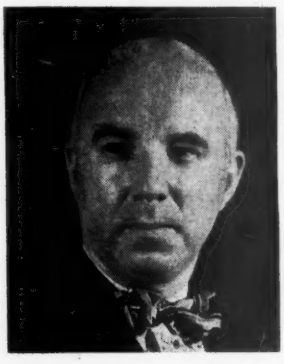
Whitney Weinrich has been appointed manager of the process engineering section of Catalytic Construction Company of Philadelphia, Pennsylvania. He will direct all research and development, pilot plant investigation, and process design for the oil refinery, chemical, and atomic energy projects of the company.

A graduate of Massachusetts Institute of Technology with a Masters degree in chemical engineering, Weinrich has been identified with process development for 20 years. He was associated with the Gulf Research and Development Company for 10 years in research and development, pilot plant operation, process design, and economic studies. He served as process engineer for a brief period with PAD and later joined Phillips Petroleum Company.

Don L. Horridge has become associated with the company in its Philadelphia engineering office as manager of the planning department. Horridge, until recently, was vice president of Tears Engineers of Dallas, Texas, and prior to the above association was chief draftsman for Process Engineers, Inc., of Dallas and the Gasoline Plant Construction of Corpus Christi. In his new assignment with Catalytic, Horridge will be responsible to the chief engineer for all plant layout in the company's petroleum and chemical division.

John W. Newton

John M. Graham



Whitney Weinrich

Don L. Horridge

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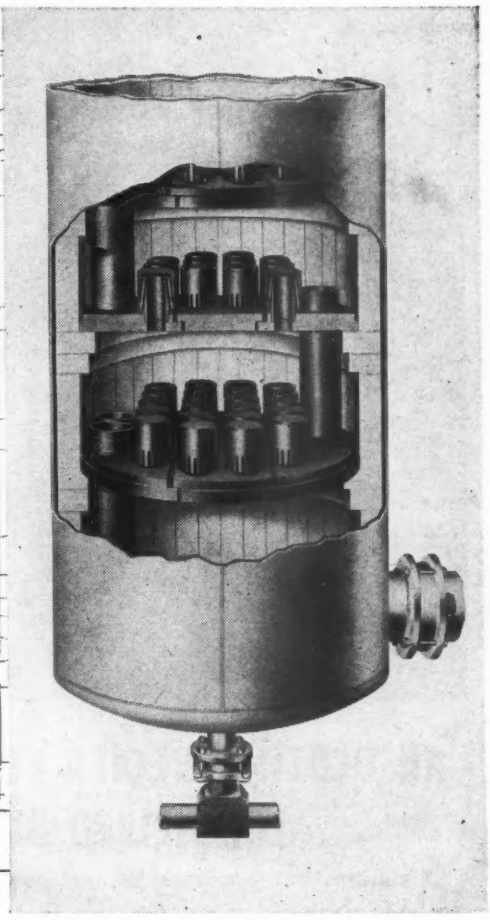

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FOR LONG LIFE AND ECONOMY

Latest DPA Refining Tax Certificates

Certificates granted by the Defense Production Administration for accelerated tax amortization for oil and gas expansion have crossed the half-millon-dollar mark. The refining industry is still receiving a good share of these certificates with latest ones listed below.

Name of company Location of facilities	Product or service	Estimated cost	Per cent
Cities Service Company St. Louis, Missouri	synthetic ammonia	$28,053,800	..
Phillips Petroleum Upton County, Texas	natural gasoline (2 projects)	11,697,745	..
Consolidated Chemical Industries Baytown, Texas	sulfuric acid	5,945,000	..
General Petroleum Corporation Los Angeles, California	aviation gasoline (three projects)	10,522,000	..
Mid-Continent Petroleum Corporation Tulsa, Oklahoma	gasoline	187,000	65
Warren Petroleum Corporation Garvin County, Oklahoma	natural gasoline residue gas	341,765 286,084	65 40
Panhandle Producing and Refining Wichita Falls, Texas	crude oil	19,250 189,162	40 65
American Liberty Oil Mount Pleasant, Texas	gasoline	2,125,000 315,000	65 45
Jefferson Chemical Company Port Neches, Texas	nonyl phenol	553,300 280,500	65 40
Skelly Oil Company Longview, Texas	gasoline	1,044,000 56,000	65 45
Shamrock Oil and Gas Corporation Sunray, Texas	dry gas, gasoline, gas oil and coke	640,427 19,550	65 50
Ralph E. Fair, Inc. Duval, Texas	liquid fuels	298,000	65
Pure Oil Company Andrews City, Texas	propane storage	213,000	40
Magnolia Petroleum Company Corpus Christi and Beaumont, Texas	gasoline	732,000 7,820,000 2,495,200	90 65 40
Sid Richardson Gasoline Winkler City, Texas	sulfur	177,350	70

Standard Oil Plans New Plant For Detergent Additive Output

Standard Oil Company (Indiana) plans a new plant at its Wood River, Illinois, refinery to expand the production of an improved detergent additive used in compounding heavy duty motor oils, it was announced by Dr. M. G. Paulus, vice president in charge of manufacturing.

Nation-wide additive production is short of meeting military and civilian requirements for heavy duty motor oils. Standard's additional production of additive at Wood River will help relieve this shortage.

The new plant is being designed by Standard Oil. The company will begin construction soon, with completion scheduled for next year.

The new detergent type motor oil additive type motor oil was introduced by Standard Oil Company (Indiana) in 1949. It prevents sludge and varnish accumulation in internal combustion engines and affords better lubrication and longer engine life, according to Dr. Paulus.

Blaw-Knox Gets Socony-Vacuum License

Socony-Vacuum Oil Company has licensed Chemical Plants Division of Blaw-Knox Company to use its technical information and processes pertaining to the catalytic reforming of petroleum hydrocarbons. This agreement supplements an earlier license to Chemical Plants Division to design and build catalytic cracking plants using the Socony-Vacuum patented processes.

Technical Service Report Available

A technical service report describing the preparation and use of lithium stearate in the making of grease has been made available upon request by Witco Chemical Company. It describes the more efficient method of preparing lithium greases and the components used in them.

In addition to noting proper procedures for best results, tables and graphs are given that show the typical properties of lithium stearate and its performance in various base oils. For copies of this report, M-12, write to Witco Chemical Company, 295 Madison Avenue, New York 17, New York.

The absence of meanders and stable wooded banks minimize the hazards to the pipe lines crossing beneath this stream bed.

tomer who depends on this gas supply has been without service for a single hour during this time.

This record of efficient service is based on three items that are the chief elements of any gas transmission system: (1) Design, (2) construction, and (3) maintenance. The purpose of this article is to emphasize the maintenance factor. As background material, however, it is necessary to touch upon the other two, design and construction.

In the routing of this pipe line, as is the case with any long distance pipe line, extremes in soils and terrain are invariably encountered. A pipe line system often traverses flat plains, rolling grasslands, wind eroded sand dunes, timber areas, slopes and gullies subjected to severe erosion during excessive rainfall, and the most serious obstacle of all, the crossing of streams and rivers. It passes through literally a thousand different varieties of soils when the physical make up and chemical constituents are taken into account. All these factors, to a varying degree, affect the design and maintenance of a pipe line system.

If it were possible to control the routing of a pipe line to avoid unstable soils, if it were possible to control climates so

Maintenance—A Challenge to Pipeliners

Gas system's ability to maintain extremely high load factor all 12 months of year due in large measure to proper care of its pipe lines

DAVID C. PALM

TWENTY years ago the Natural Gas Pipeline Company of America completed and began operating the first large diameter, long distance, high pressure pipe line for the transmission of natural gas. It extended from the fields of the Texas Panhandle to the markets of the Chicago area and also delivered gas to certain towns and cities along the route. The original line was 24 in. in diam and 898 miles long, exclusive of the main trunks of the gathering system. The line's capacity was 175,000,000 cu ft a day. A 26-in. looping program, begun in 1941 and completed in 1947, increased the capacity of the system to 510,000,000 cu ft a day.

During the last 10 years, the company has been able to maintain an extremely high load factor for the entire 12 months of the years and has also maintained a high degree of service to its distributing utilities. No domestic cus-

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Jetties constructed from car frames confine this river at a bend upstream from the pipe line crossing.

there would be no extremes of precipitation, if no soils were excessively corrosive, if all pipe lines were perfectly coated or were at least well coated and cathodically protected, if rivers were stable and spots of scenic beauty at all times and never in a flood stage, if hydrates never formed to block the passage of a gas stream, and if we were to go on and add some more ifs, the work of the maintenance crews would be simplified to the extent that they would need to maintain only the mechanical portions of the system such as valves, meters, and the specialized equipment used on a pipe line. Only a token force of employees would be needed on such a pipe line system. But in nature there is nothing stable, and accepting this fact, a pipe line maintenance organization is a versatile group of resourceful men working to keep a pipe line system in condition to transmit efficiently natural gas for 24 hr every day and 365 days every year.

The original 24-in. line of the Natural Gas Pipeline Company system was laid with alternate joints welded and joined by Dresser couplings and completely field coated with coal tar enamel. Field bends in pipe joints provided the major deflections so as to minimize angles at the couplings. Solid welded sections of pipe were used under watercourses. Multiple lines crossed under the major rivers.

Many of the original stream crossings have been looped or rebuilt, considering design factors observed during the early years of operation such as meanders, gradients, types of stream beds, and watershed and flooding characteristics. Experience of the pipe line companies has proved that it is important not to underestimate the tremendous forces exerted by rushing flood water, water borne debris, ice jams, undermines by scouring streams, or bank washouts caused by meanders.

The second 26-in. line of the system was of solid welded construction and utilized higher tensile steel in the pipe walls. Other technological developments such as better construction equipment, better welding techniques, better pipe coatings, and better valves resulted in a line of more advanced design. This development in the engineering practices in the newer pipe lines versus the older ones clearly stresses the need for more maintenance work on the older lines to keep them operating at full efficiency.

The Basic Problem

Basically a pipe line in continuous operation year after year requires a combination of good design, construction, and maintenance so that the pipe line rests in stable surroundings. Whether it is laid in a river bottom or on eroding slopes it must remain undisturbed by outside forces so that the steel of the pipe wall is not called upon to resist any appreciable stresses except those imposed by the internal pressure of the flowing gas stream.

To prevent these disturbances it is necessary to maintain a stable backfill condition. Such a program will vary with the terrain, but under conditions of erodable soil, steep slopes, and heavy rainfall, it becomes a major part of pipe line maintenance, utilizing the scientific know-how in the field of soil conservation.

The use of direct electric currents to overcome the alternate anodic and cathodic condition of pipe lines caused by the variables in the more corrosive soils is a practice that is now so general on long distance pipe lines that it is accepted as axiomatic. Cathodic protection on our lines dates back to 1938 and has been expanded from year to year to keep ahead of the destructive forces that cause the steel to corrode.

The practice on our lines is to use rectifiers primarily, but numerous areas of coupled lines are protected by magnesium anodes where soil conditions and moisture are favorable for sacrificial anodes to react. As cathodic protection is such a broad subject, however, no attempt will be made to discuss this subject except to mention its importance in pipe line maintenance.

Stream Crossings

The pipe lines of the Natural Gas Pipeline Company of America cross 33 major streams that were considered important enough to justify multiple lines under the riverbeds. In this group are streams appearing somewhat minor when viewed month after month but which drain immense watersheds and become raging torrents during periods of excessive rainfall. At the other extreme are the Missouri and the mighty Mississippi. There are about 100 other watercourses classed as minor stream crossings because of the limited watershed that they drain. They usually have a steep gradient at the location of the pipe line crossing, however, that is high

The Author

David C. Palm, general superintendent of pipe lines for Natural Gas Pipeline Company of America and Texas Illinois Natural Gas Pipeline Company, has spent his entire engineering career in the petroleum industry. Shortly after receiving his engineering degree from Stanford University he went to work for the Empire Companies, Bartlesville, Oklahoma. In 1931 he was employed as a construction engineer and inspector by the Continental Construction Corporation while the Natural Gas Pipeline Company line was under construction. He supervised pipe line construction on the 24-in. line and the 26-in. line looping program as well as construction of station facilities. He has had experience in the construction of oil and gas transmission facilities including compressor stations, oil pump stations, refineries, high pressure gas lines, meter stations, and field pipe line construction.

Palm was district superintendent and division superintendent of pipe lines of NGPL and in 1948 became superintendent of pipe lines.

Although this stream presented problems to the pipe line engineers, the lines are safely laid deep under the bed a short distance downstream from this view.

on the watershed, giving them importance from the standpoint of maintenance.

At every river crossing, the pipe lines are submerged and weighted except one line, which is carried on a bridge across the Missouri River as an addition to a submerged crossing. Where multiple lines are used, the headers and valves are so situated that they are protected from flood waters and are accessible at all times to the maintenance crews. The success of the engineering and maintenance on the system's river crossings is demonstrated by the fact that no operating interruption has taken place as the result of the loss or breaking of a river line. One pipe line break did occur some years ago during a period of heavy rainfall. The drainage from a slope near a stream uncovered the pipe line near the bank. Since that time, an intensive program of controlling water falling in the vicinity of streams and providing a safe means for it to flow into the stream itself has been carried on and there should be no reoccurrence of this unfortunate experience.

The 33 streams mentioned fall into many classifications from the standpoint of watersheds, flooding characteristics, gradients, and meandering tendencies. There is the deep sand bed type of river of the plains region of the southwest. There is very little flow in them normally but these streams drain a tremendous watershed and flash floods are common. During the flood stage they carry a heavy silt load and are classed as aggrading streams because of the tendency for the bed to build up deposits dropped by receding highwaters. They usually meander over a rather wide sandy area, which is bounded by definite banks. The problem here is to lay the pipe line so that it rests in relatively stable surroundings deep under the shifting sands of the river bed for a distance that prevents meanders from threatening the lines at the banks. There are streams with a steep gradient continuously deepening as the result of the scouring action of the current. And there are a few lazy streams with wooded banks that flow and flood in a very orderly manner! There is nothing stable about the banks of the average river, however.

The problem of crossing a river with a pipe line is simply, or not so simply, determining the farthest boundaries of the river during the design and construction phase and then maintaining the river channel within these boundaries.

Extensive use has been made on the Natural Gas Pipeline Company system of a combination of mechanical and vegetative means of bank control. Interlocking steel to form jetties is in itself a good means of subduing eroding stream currents. The velocity of the water is reduced in coursing its way through the mechanical barrier provided the current is not so violent as to dislodge the jetties. The same is true of vegetative growth such as the small varieties of willows that flourish on sand bars. These form a dense but low growth on the banks of streams. We have found them to be very effective in reducing the water velocity in the area near the soil surface. These growths, if properly selected, although dense, are also supple to the extent that the current will bend them without permanent damage to the plants. Although willows native to the local areas are perhaps the most widely used plantings for bank protection, other vegetation may be used that are adaptable to the soil and climate of the area involved. But, again, plant life is not effective against violent currents, although added safety can be obtained by a combination of mechanical and vegetative bank control. On the

Flash floods have a devastating effect on small streams. The company's 24-in. line crosses under this stream in the foreground of the picture. Watershed control is the only effective means of minimizing the damage of this type of stream.

A steep bank on the west side of the Missouri River. Now protected by terraces and grass, there was once a serious gully here which endangered the pipe line.

Cimarron River in southwestern Kansas, our company utilizes a steel post and wire mechanical control system interspersed with plantings of native willows and tamarack. This project has been in service for eight years. Another means of mechanical control of banks has been the use of creosoted wood piling and retaining walls. We have found, however, that a sound design is essential if this type of revettment is to stand up against the forces of the flood waters.

Pipe line maintenance men become conservation-minded as they observe the destructive forces of water. They look with favor upon the projects that hold rainfall on the watershed and disperse much of it to the streams by the medium of underground water. On major streams, the project is often a reservoir for impounding flood waters. On a minor watercourse, terraces and farm ponds on the watershed of its upper tributaries are utilized to prevent heavy damage by rainfall. Slopes that are too steep for cultivation without inviting undue soil erosion are restored to grasslands. Whenever projects of this nature are developed in the vicinity of the pipe line right-of-way, it is the practice of our organization to work cooperatively with the farmer or rancher to serve the interests of all parties involved.

Modern Equipment

No discussion of pipe line maintenance is complete without mention of the modern tools that are in the hands of the maintenance crews for their use in efficiently carrying on their work. In addition to modern transportation equipment and mechanized digging and earth moving equipment, which has replaced the pick and shovel, brief mention should be made of the patrol plane and two-way radio communication. With the use of these two facilities the entire span of the pipe line is under close observation of an experienced pipe line patrol pilot and by use of radio equipment, maintenance men are dispatched to a trouble spot at any location on short notice.

In an analysis of the maintenance of a pipe line system, unquestionably the greatest factor is the human one. Men must man the pipe lines and be ever on the watch for the numerous hazards that can encroach upon the safety of their project. Our company prides itself upon having developed supervisory personnel and men in the maintenance crews who have a deep sense of the responsibility of their jobs and who, by experience and training, are skilled and able to perform an unusual amount of preventive maintenance work so that maintenance programs can proceed on a planned basis ahead of the urgent need for such work. Their work on the maintenance of the system and efficient teamwork in making repairs when these become necessary, have been an all important factor in the company's favorable record of gas service to the consuming public that it supplies. * * *

P 615.

Rancho Pipe Line Under Construction

THE Rancho Pipe Line System, a multiple-ownership crude oil line between McCamey and Houston, Texas, is now in the course of construction. Entrusted to Shell Pipe Line Corporation is the design, construction, and operation of this $35,000,000, 455-mile, 24-in. pipe line. Six other companies besides Shell participate in the ownership, Sinclair Pipe Line Company, Pan American Pipe Line Company, Ashland Pipe Line Company, Nantucket Pipe Line Company, Phillips Pipe Line Company, and Crown Central Petroleum Corporation.

Initially the Rancho line will have three pumping stations, with later plans for five more. The three stations will be at Mesa, adjoining the present McCamey tank farm of Shell; Bailey, just south of Eldorado, and Garfield, four miles east of Austin station. With the three stations the capacity of the system will be 210,000 bbl a day and with eight stations 345,000 bbl.

Anderson Brothers Corporation has contracted to lay the 267-mile section from McCamey to Cedar Valley, a few miles west of Austin. Houston Contracting Corporation will lay the 188 miles from the latter point to Houston, and will install crossings of the Colorado and Brazos rivers. Chicago Bridge and Iron Company has been awarded a contract to erect 1,200,000 bbl of tankage at McCamey. A field office has been opened by Shell at Austin.

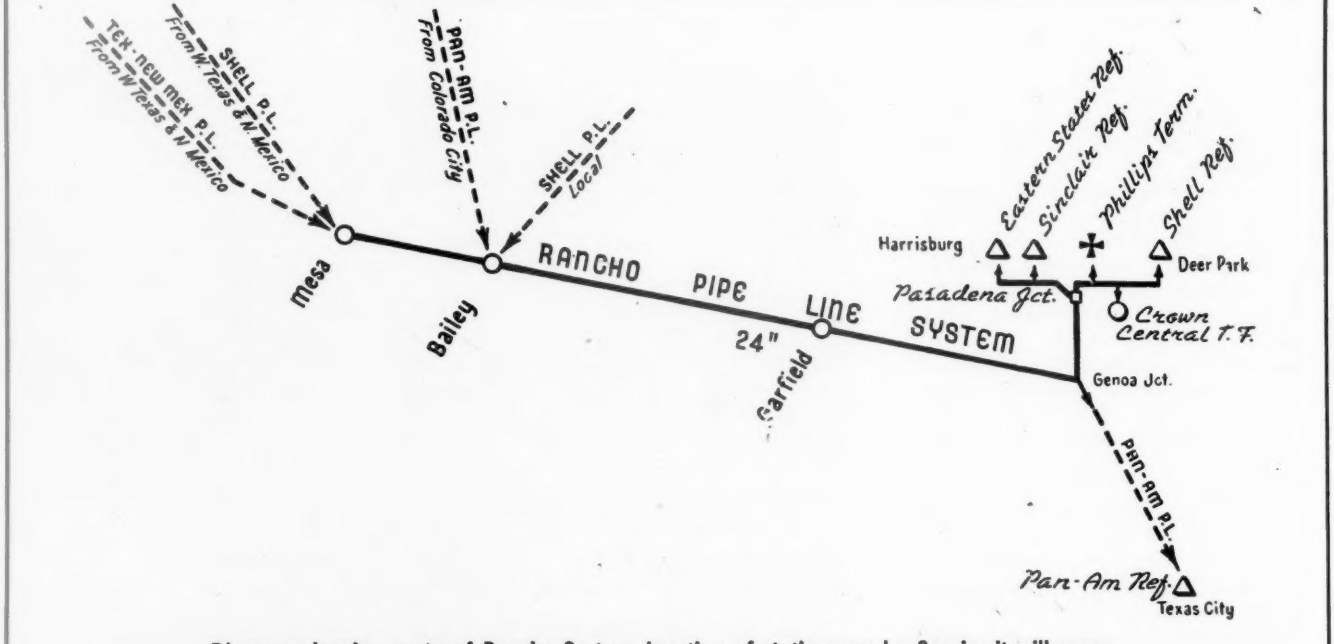


Diagram showing route of Rancho System, location of stations, and refineries it will serve.

Ready to start its quick trip through H. C. Price Co.'s Hevicote plant on Staten Island, this joint of Somastic-coated pipe is set on rubber wheels that rotate in set ratio with speed of dollies along the fixed track.

NEW PIPE COATING PROCESS

Heavy concrete-type coating now applied by impact method

FRANK H. LOVE*

A NEW method of applying Hevicote to line pipe to give it negative buoyancy and protection from corrosion has been adopted by the H. C. Price Co. The impact method, the name by which the new process is known, was first used on Transcontinental Gas Pipe Line Corporation's Arthur Kill crossing of the Hudson River to take gas into the Brooklyn area. The crossing was completed this spring. The same method of application is now being used to coat pipe for Transcontinental's crossing of the Narrows on the Hudson River.

Hevicote is a concrete-like substance developed several years ago by the Price company to provide an exterior coating sufficiently heavy to assure permanent anchorage of marine pipe line crossings. Until the Arthur Kill crossing it had been applied by the extrusion method, with the pipe in a vertical position. This method, however, had its disadvantages. Its application was limited to pipe lines of 22 in. diameter or less because it was impossible to place sufficient wire reinforcement on the pipe for thicker coatings required by the larger diameters. A further disadvantage was that it was difficult to produce Hevicote that would weigh more than 150 lb per cubic foot, even with a carefully graded sand aggregate. With the impact method, in which the pipe is coated while in a horizontal position, the weight can be increased to 175 lb per cubic foot due to the dense compaction of the coating. When even greater weight is desired barytes can be substituted for sand to bring the weight to approximately 200 lb per cubic foot.

Another important feature of the new method is that it requires considerably less equipment than the vertical method, and can be set up at railhead locations in a short period of time and at a reasonable cost by a smaller crew.

Production line techniques are employed in the application of Hevicote by the impact method. Although only one joint is coated at a time, the pipe passes through the plant in a steady flow, with a bare joint being placed in position as each coated section is removed.

The pipe rests on rubber wheels set on two dollies, one called a drive car and the other a trail car. The former is powered by an electric motor with adjustable speeds that control the revolutions of pipe according to the speed at which the coating is applied. The dollies move along stationary tracks 36 in. apart erected on a 4-in. foundation of concrete. The pipe makes a complete revolution for every 3½ in. that it moves forward to provide a ½-in. lapping of the 4-in. wide wire reinforcement.

As the bare joint passes through the coating plant, it is bombarded with a stream of Hevicote thrown at it by two high speed, rotating wire brushes. The impact speed of this material is more than 6000 ft per minute, which causes

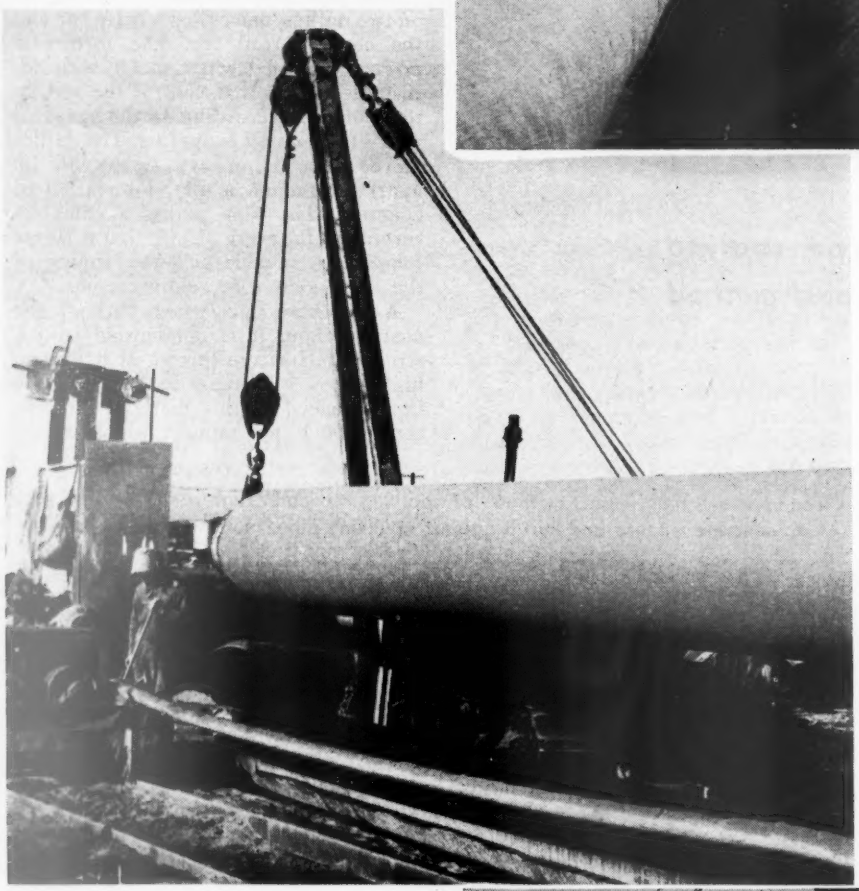
Close-up shows the "impact method" of applying Hevicote. High speed brushes pick up concrete mixture and hurl it against revolving pipe. Note wire reinforcement.

*Editor, Oil and Gas Pipelining.

EXCLUSIVE

it to build up around the pipe in a very dense formation free of voids. The wire brushes, placed 21 in. from the pipe, are 12 in. in diameter, 10 in. wide, and have 3¼-in. "whiskers". The brushes are mounted in tandem so that they rotate in opposite directions. As the coating material is forced into the rear of the brushes, rotating between 2100 and 2200 rpm, it is caught up and hurled against the pipe. The thickness of the coating is regulated by varying the speed of the two brushes. In order to facilitate the application of corrosion-prevention coatings in the field, application is stopped approximately 15 in. from the end of each joint.

As the coating is applied to the pipe it is reinforced by a continuous flow of 1-in. by 1-in. 18-gage galvanized mesh wire 4-in. wide. Approximately 500 ft of wire is required to reinforce a 1-in. layer of coating per 40-ft joint of 26-in. pipe. This wire is attached to the feeder spools and passed over two fair lead spools for controlling the festooning around the pipe. A compensator permits splicing a fresh spool while wire continues to run.



The coating material is fed into the plant in portions of one part cement and two parts aggregate or barytes, as the case may be. These raw materials are metered as they pass through a reciprocating feeder to a conveyor system where a small quantity of water is added and the coating is forced into the revolving wire brushes.

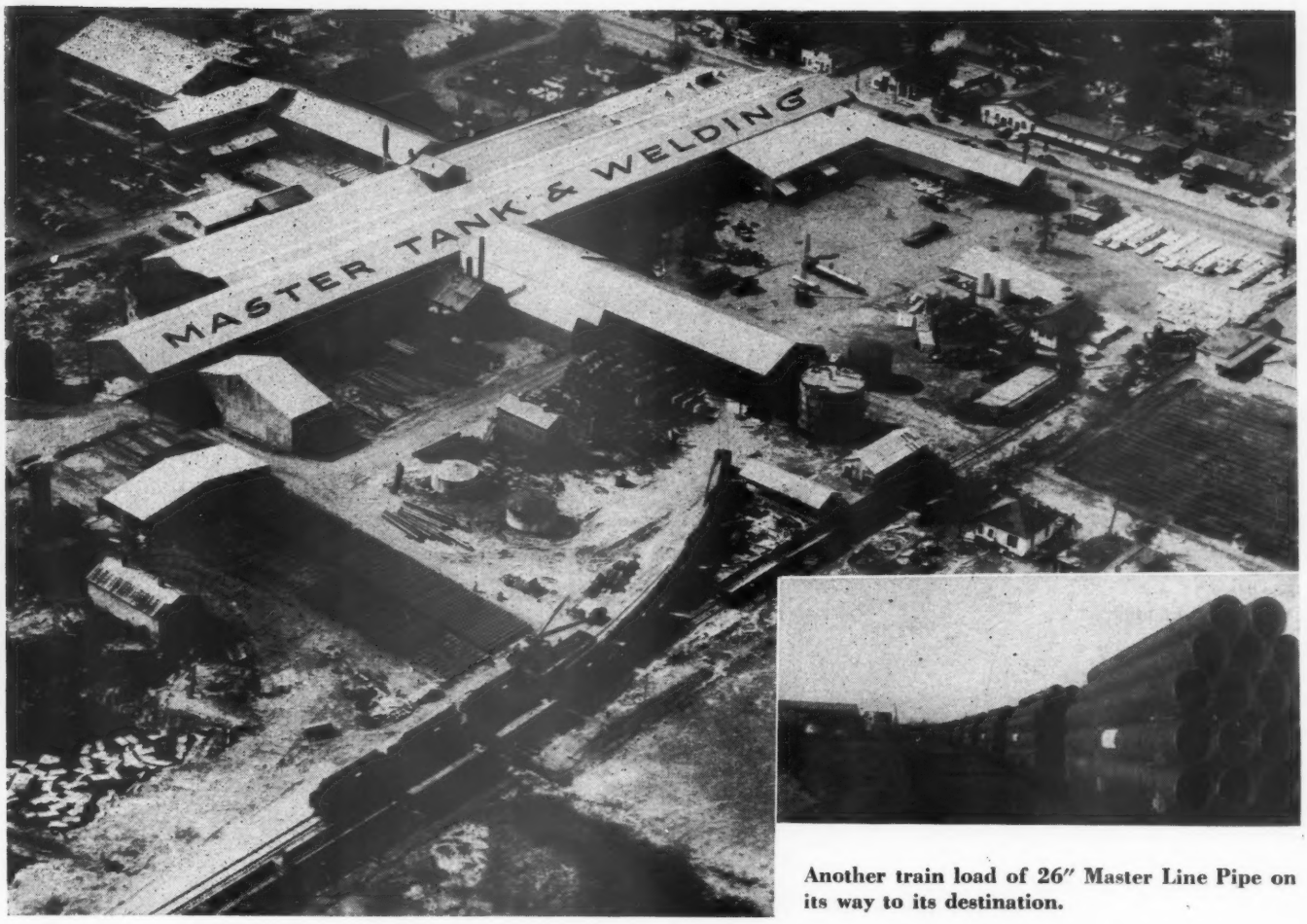
As the coated pipe moves forward it encounters a fixed brush that trims off all excess material and leaves a smooth coating with a uniform thickness. The excess material is returned to the plant by a rebound conveyor set in a steel trough beneath the pipe.

Immediately after coating, the pipe can be stockpiled, and following a curing period of 4 or 5 days it is ready for laying. A joint of pipe thus coated can be handled by a construction crew with only ordinary precautions necessary to avoid damage. * * *

Top, a dynamometer is used to weigh a joint of 26-in. OD pipe to determine whether sufficient negative buoyancy will be obtained when the pipe goes into a marine crossing.

Center, a freshly-coated joint of pipe is removed to the stockpile for a brief curing period.

Right, to keep the pipe afloat during river crossing operations, huge pontoons were strapped to the pipe used for Transcontinental's Arthur Kill crossing.



Another train load of 26″ Master Line Pipe on its way to its destination.

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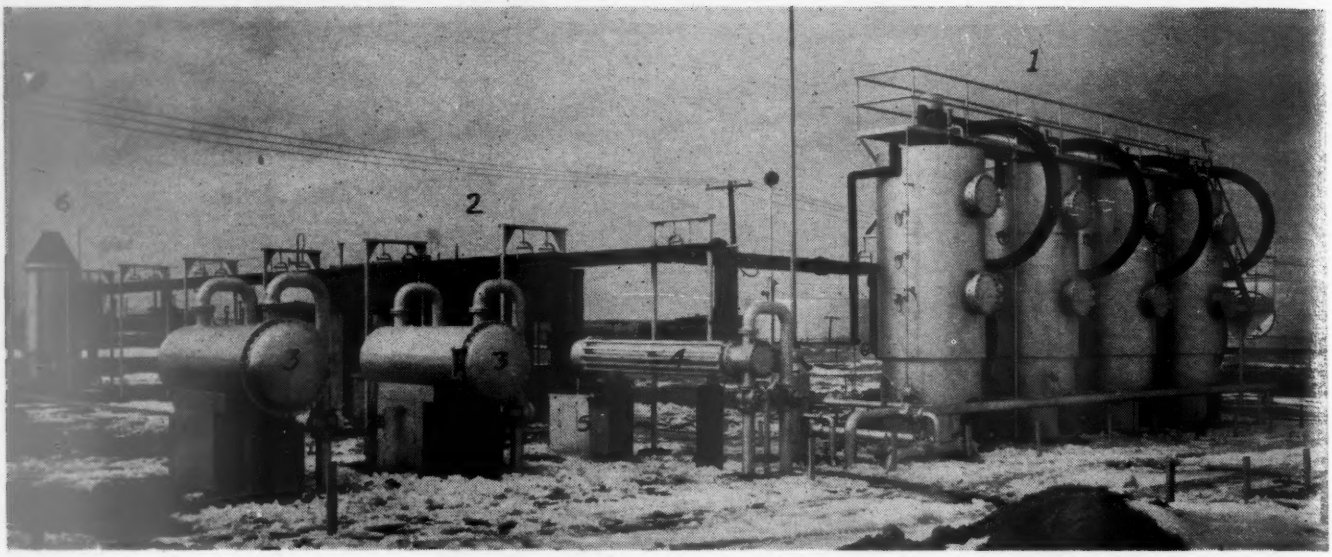


Strouds dehydrator looking northwest.

1—Towers
2—Control building
3—Water separators
4—Heat exchanger
5—Knockout drum
6—Gas heater

Dehydration on Products Pipe Line*

Description of equipment installed by Wyco Pipe Line as protection against internal corrosion

R. P. DOUGHERTY

In the process of manufacture of gasolines and certain distillate fuels, the products are washed with water for the purpose of removing undesirable compounds and finely divided solids that may be carried over from the treating plant. This washing is effected just prior to running the products into their respective storage tanks. Consequently, products received at the point of origin of a pipe line contain adsorbed water and water in solution. Inner surface rusting of the pipe is a direct result of precipitation of this water from the product while the product is in the line.

Commonly, two entirely different methods of preventing internal corrosion are used by pipe line companies. One method consists of injecting rust inhibitors, either water soluble or oil soluble, directly into the products pumped. These inhibitors so coat the interior of the pipe that the water does not attack the metal. The other method is to dehydrate the products so that no free water can precipitate in the line and cause rusting. Both methods have their adherents and both perform the required function of preventing internal corrosion. Our purpose here, however, is to discuss only the latter method, dehydration.

During June of 1950 the Wyco Pipe Line Company began dehydrating products received into its line at the Strouds, Wyoming, pumping station. In so doing Wyco became the third products pipe line to use dehydration for protection against internal corrosion.

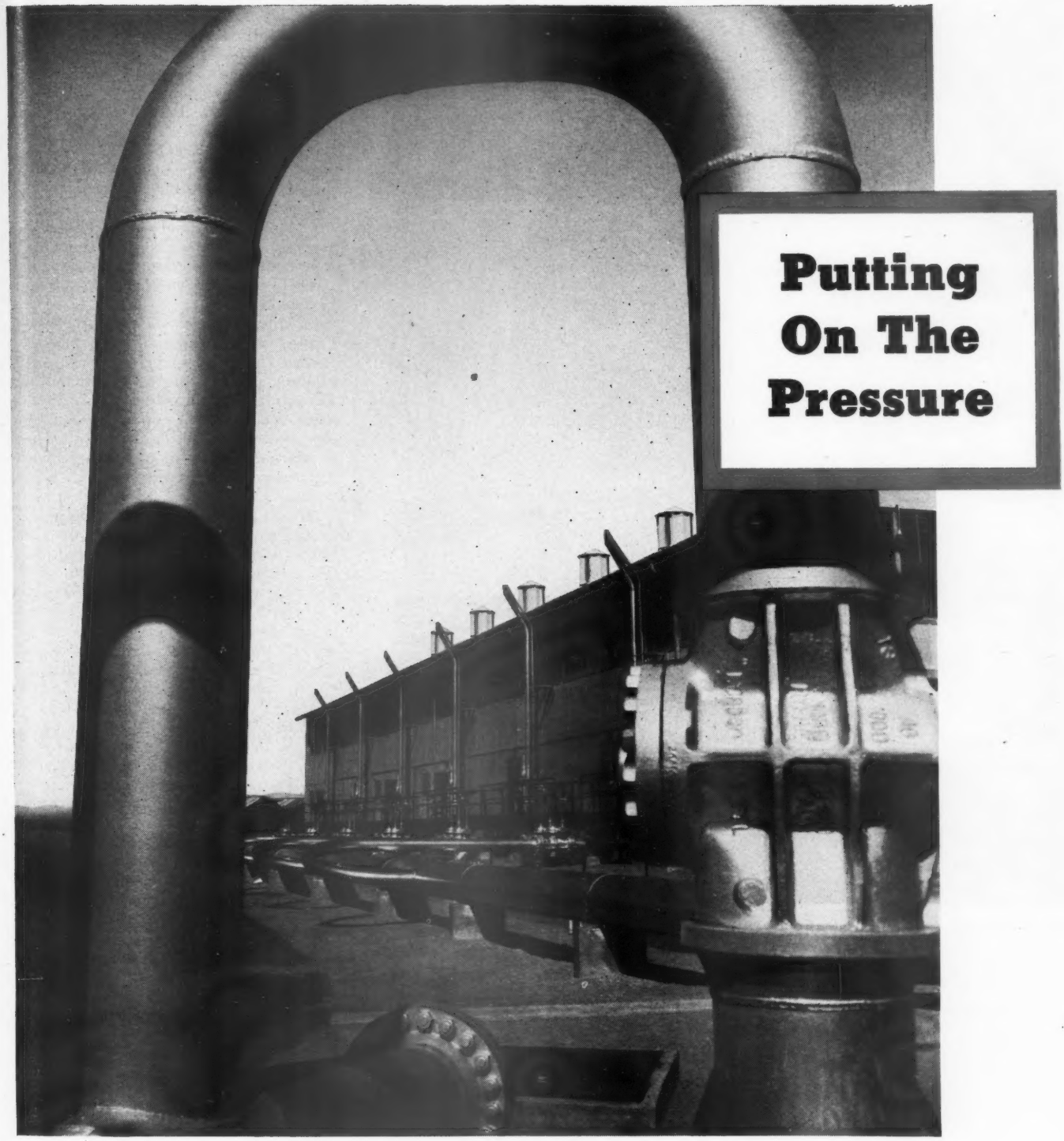
Much credit for the development of products pipe line dehydrators is due the Socony-Vacuum Oil Company, who pioneered the process in 1936 when it built a pilot dehydration plant at its East Providence, Rhode Island, pumping station. With the evident success of the pilot plant, Socony immediately began construction of full capacity plants at East Providence and Augusta, Kansas. Subsequently, the company built dehydrators at Buffalo, New York; Paulsboro, New Jersey; Portland, Maine, and Trenton, Michigan.

The Phillips Pipe Line Company was next to use dehydration on a products pipe line when in 1947 it began dehydrating its Borger-Denver line. Since

*Presented before American Petroleum Institute, Division of Transportation, Products Pipe Line Technology Conference, Fort Worth, Texas, April 21-23, 1952, under the full title "A Description of Dehydration Equipment and Practices On a Products Pipe Line."

The Author

R. P. Dougherty spent three years as a field and construction engineer for the Central Public Service Corporation prior to joining the Standard Oil Company (Indiana) in 1933 at Muskegon, Michigan. Successive promotions sent him to Council Bluffs, Iowa, Indianapolis, Indiana, and Standard's general office in Chicago where he was in charge of pipe line and river terminals. Dougherty left Standard in 1947 to affiliate with the then newly formed Wyco Pipe Line Company, where he now holds the position of general superintendent. He is a 1929 graduate of Webb Institute of Naval Architecture and Marine Engineering.



BECHTEL ALL THE WAY—PLAN TO PLANT...

Needles Compressor Station, recently completed for Pacific Gas and Electric Company.

BECHTEL

THREE new compressor stations—at Needles, Hinkley and Kettleman Hills, California—are pushing 400 million cubic feet of gas per day through the 500-mile "Super Inch" pipe line—doubling its former capacity and saving 18 hours in transit time.

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Gas heater unit of Strouds dehydrator.

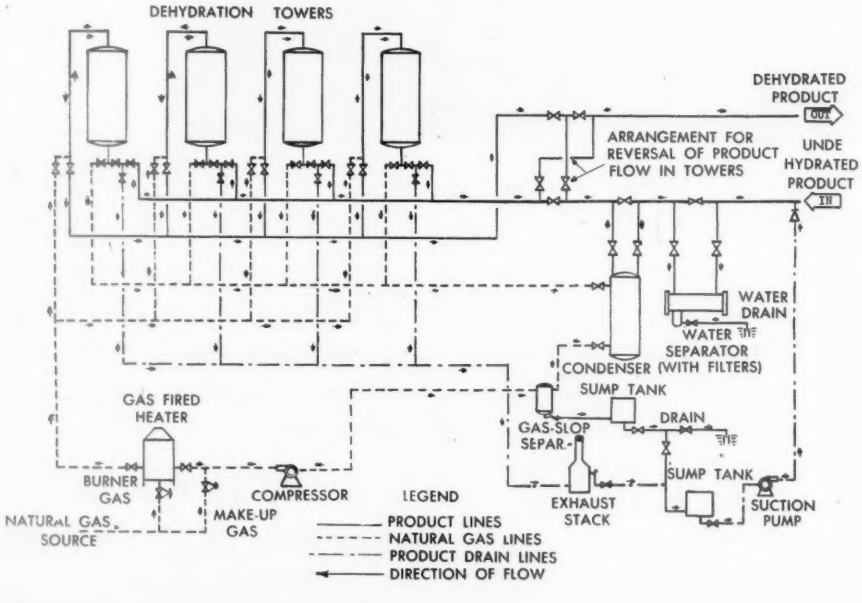


FIG. 1. Process flow diagram for Strouds dehydrator.

then, Phillips has installed dehydrators on its Borger-Chicago system and now has two plants at Borger, Texas, and one at Dumas. Additional units are under construction at Paola, Kansas, and Dupo, Illinois.

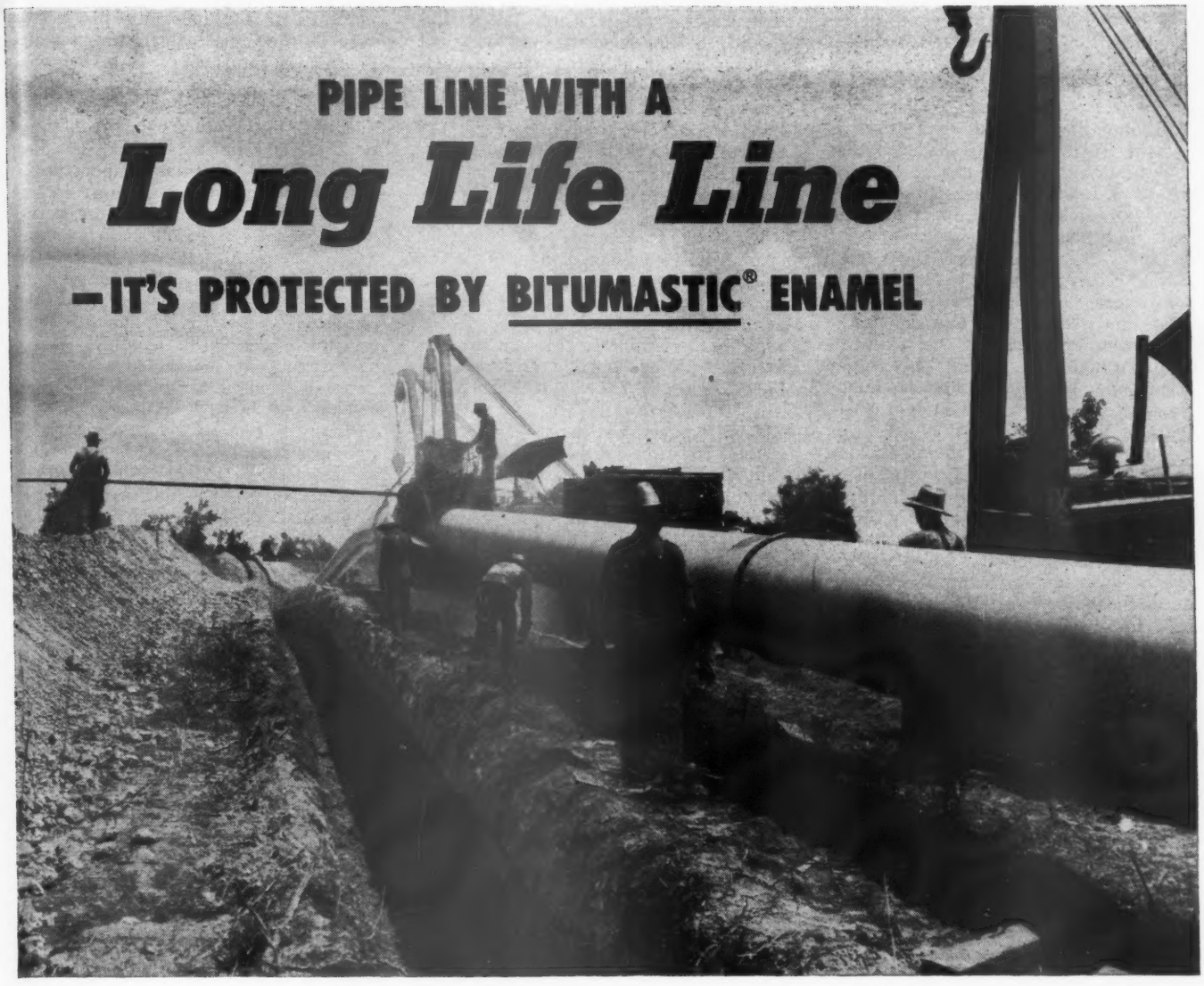
In the fall of 1950 Standard Oil Company (Indiana) placed in operation a dehydrator at Whiting, Indiana, and began dehydrating products on its Whiting-Moorhead, Minnesota line. Standard recently completed construction of a dehydrator at Neodesha, Kansas, and plans to construct another unit at Sugar Creek, Missouri.

All present products pipe line dehydrators are closely similar in most respects. This is not surprising because all of them perform the same function on the product in the same way with the same medium. All partially desiccate the product by passing it through a bed of activated alumina and all use heat for regeneration of the desiccant after it has become saturated with water. It is only in the medium used for applying heat to the alumina bed to vaporize the water, and in the method of exhausting the adsorbed moisture from the bed, that the various dehydrators differ materially. Socony applies heat at some plants by passing superheated steam directly through the alumina bed and at others by means of steam in closed coils. Phillips passes hot butane vapor through the bed at all of its plants. Standard of Indiana uses steam in closed coils at its Whiting dehydrator, but at Sugar Creek and Neodesha regenerates with natural gas. The Sugar Creek and Neodesha units are quite similar to the Wyco dehydrator, which Standard also designed. Logically, the selection of the method of regeneration must be based on economics and local considerations. At Strouds our selection was easy. There was no steam available. Naphtha was plentiful but expensive. Dehydrated natural gas, free of harmful sulfur compounds, was plentiful and cheap. We decided on natural gas.

As noted above, the various dehydrators in operation on products pipe lines are scattered widely over the country. Therefore, rather than attempt to describe all dehydration plants and practices, this paper will confine itself to a description of the construction and operation of the natural gas regeneration dehydrator installed by the Wyco Pipe Line Company at its Strouds, Wyoming, pumping station.

The Strouds dehydrator, Fig. 1, has a capacity of 20,000 bbl a day with two towers on streams in parallel. It was designed to give full protection to the line assuming that the incoming products would be completely saturated with water at all times.

Incoming product first passes through an Excelso Pack water separator for the removal of entrained water. As would be expected, considerably more water is removed at this point during cold than warm weather, because of the greater precipitation in the incoming lines. From the water separator the product goes directly to the towers un-



This pipe line was coated with Bitumastic Enamel—then wrapped.

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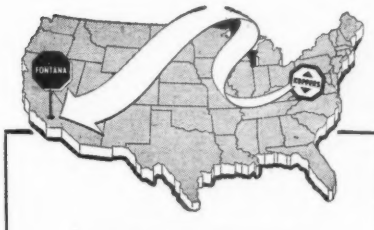
Bitumastic Enamels give pipe lines the best possible protection against all kinds of corrosion. Here's one reason: through the years these coal-tar enamels *keep* moisture away from pipeline surfaces, thus preventing corrosion. Two more reasons: these durable enamels don't disintegrate with age; they are chemically resistant to soil elements.

Because of Bitumastic Enamels, many oil and gas pipe lines laid 20 and 30 years ago are still giving good service today. Specify Bitumastic Enamels for your next pipe-line project, and give it the same effective protection. Your Koppers representative will give you complete details and estimates.



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less another tower is in process of regeneration, in which case the stream is sent through a heat exchanger to cool the gas leaving the tower that is being regenerated.

Product flow through the towers is upward. A provision is made so that flow through the towers can be reversed if desired. It was expected that unidirectional flow might so compact alumina fines and accumulated sediment that pressure differential across the towers would become excessive. If such a situation occurred, reversed flow would dislodge and disperse the fines and sediment, thereby reducing the pressure drop through the towers. To obtain proper operation of the Strouds pumping station, pressure drop across the dehydrator should not exceed 40 psi. With the pressure drop across the auxiliaries reaching 20 psi at times, a maximum of 20 psi drop across the towers is allowable. Inasmuch as the greatest drop recorded to date across these towers has been 5 psi, it has never been necessary to back flush the desiccant. Winnowing the desiccant to remove dust and fines prior to placing it in the towers will help to keep the pressure drop down by reducing the amount of fines available to pack the voids in the desiccant bed. When two or more towers are on stream it is desirable that the flow through the towers be equalized. This is accomplished by installing a flow meter on the intake line to each tower, thus enabling the operator to balance the flow by manipulation of the tower intake valves.

To determine the effectiveness of the dehydrator, samples are taken frequently of the incoming and outgoing streams and titrated for water content by the Karl Fischer titration. The curves in Fig. 2 show the parts per million of water required to saturate the several products at various temperatures. From the curves it is evident that the temperature of a product determines the amount of water that that product will adsorb. It is the purpose of dehydration only to remove sufficient water from a product to lower the water content below saturation at the lowest temperature the product will encounter while in the pipe line. This temperature is referred to as "low line temperature." Further dehydration below this point will not further protect the line, but will add only a factor of safety to the protection. It is, of course, not possible to dehydrate at an even rate throughout the period that towers are on stream.

After determining the ppm of water in the outgoing product and the low line temperature, reference to the curves shown in Fig. 2 will indicate whether the towers may be continued on stream or not. If the ppm water in the dehydrated product falls above the curve for that particular product at the low line temperature, water will precipitate into the line, and the towers must be changed immediately; towers are actually changed before they reach this point.

The length of time that a pair of towers can be left continuously on stream without regeneration varies considerably because of the many factors that affect it. For example, if the temperature of the incoming product is near the low line temperature and the product is saturated with moisture, a comparatively small amount of water must be removed to assure protection of the line. On the other hand, if the temperature of saturated product is much higher than the low line temperature, a greater amount of water must be removed and regenerations must necessarily be more frequent. It is possible, and sometimes happens, that even though the incoming temperature is above the low line temperature, the product is well below the point of water saturation. When this condition exists, the product can be cooled several degrees without moisture precipitation, and it may not be necessary for the desiccant to remove any water at all. A similar situation occurs when the low line temperature is higher than the temperature of the incoming product. Regardless of whether actual dehydration of adsorbed water is required, however, products are always routed through the entire dehydration plant to assure that no free water is ever allowed to reach the pipe line. Other factors affecting the frequency of regeneration are pumping rate, percentage of water saturation of the product, condition of the desiccant, and type of refined product being pumped. We have noticed that when dehydrating distillate fuels, more frequent regenerations of the desiccant are apparently required than when dehydrating gasolines.

Towers are regenerated as soon as possible after taken off stream. In the regeneration cycle the towers are first emptied of product while being simultaneously filled with gas. Inasmuch as the suction pressure to the main line pumps can be reduced below 80 psi and

FIG. 2. Water solubility at various temperatures.

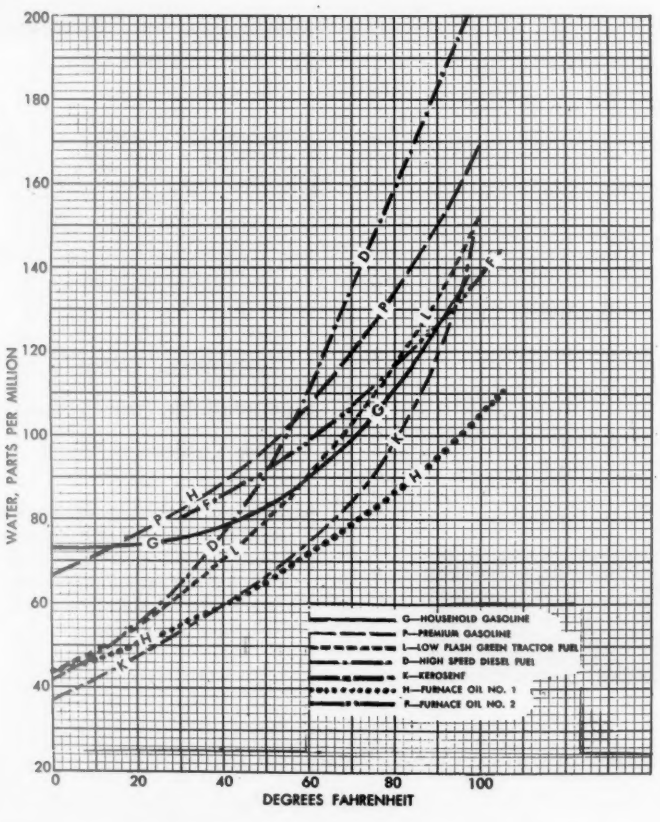
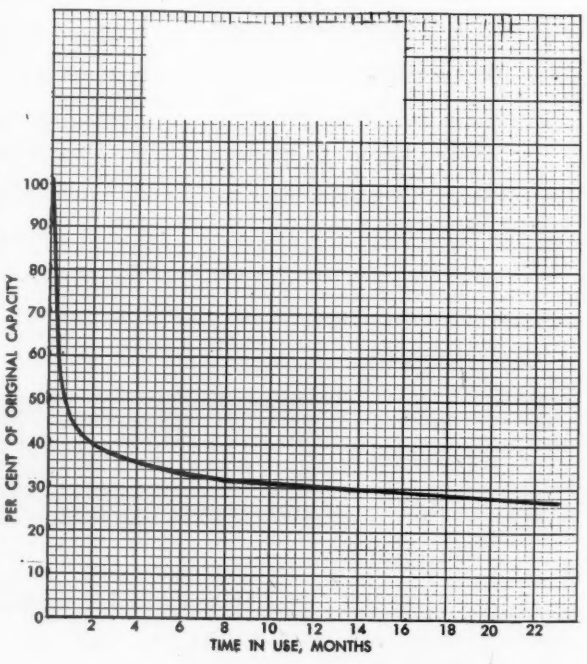


FIG. 3. Decline in adsorption capacity of 8-14 mesh activated alumina.



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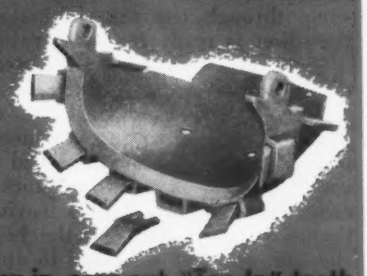

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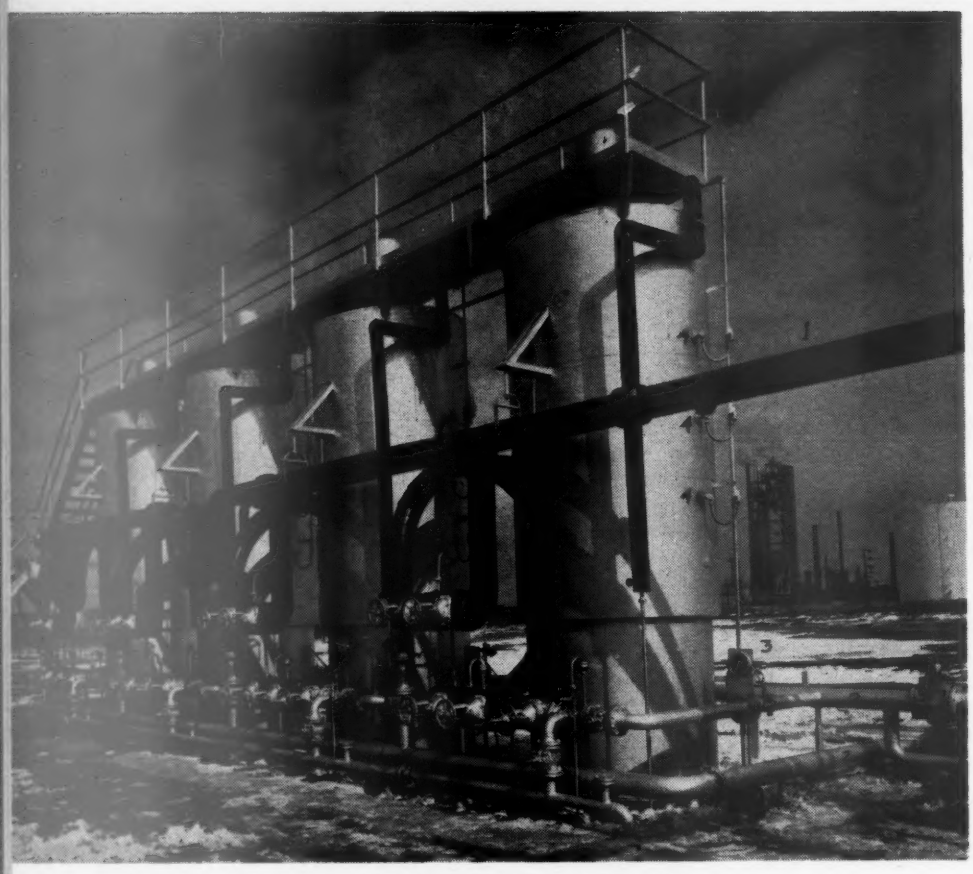


Dehydrator towers looking northeast.

1—Hot gas lines
2—Product lines
3—Flow meter
4—Thermocouples

also since 80 psi is maintained on the natural gas lines, it is a simple expedient for the operator to admit gas into the top of the tower and force the product down and out into the intake line leading to the towers on stream. As soon as the first bubble of gas appears in the test connection at the bottom of the tower, the product intake valve to that tower is closed and the tower is allowed to rest for about an hour to permit holdup products to drain down. This holdup stock is then drained to the sump through the gas eliminator and the tower is ready for regeneration.

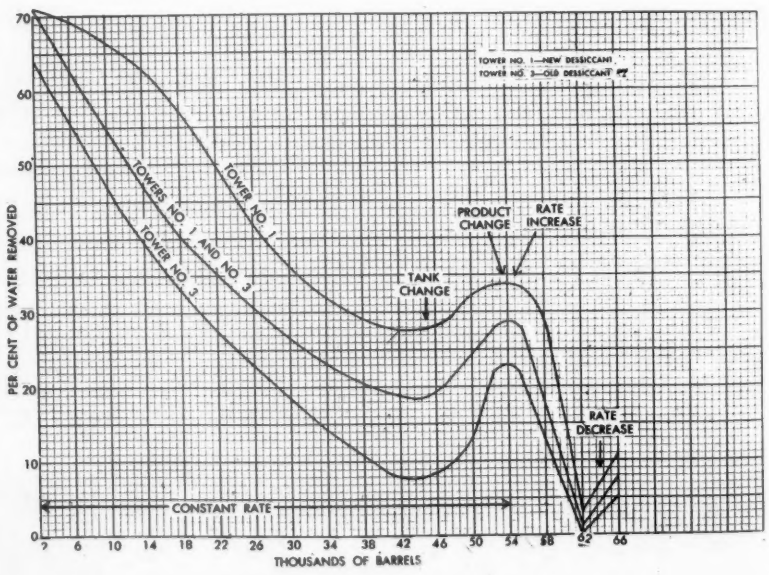
Next the compressor is started and the gas heater turned on. The hot gas, maintained at 500 F at the heater outlet, passes downward through the desiccant bed and vaporizes the adsorbed water and any remaining holdup stock. The mixture of gas and vapors leaving the towers is routed through the heat exchanger where it is cooled to approximately 100 F, condensing out the holdup stock and water, which are collected in and decanted from the gas-slop separator or "knockout drum." The slop, or water-product mixture, flows to an aboveground slop tank where it is allowed to settle for a short time. Then the water is drained off to a dry well and the product allowed to flow into the sump tank. Products in the sump tank are pumped back into the dehydrator intake line so that no undehydrated product enters the pipe line. The sump tank is always pumped out while the same product is on stream as is in the tank in order to prevent any possible contamination.

From the knockout drum the liquid free gas re-enters the compressor where it is recompressed to recover the pressure lost in passing through the system. The process is continued until the entire bed has been heated to 375 F. At this point the heater is turned off but the gas circulation through the tower is continued until the bed temperature is lowered to about 100 F. The cycle is then complete and valves are closed leaving the tower full of gas. It usually takes between 2 and 3 hr to raise the desiccant bed in one tower to 375 F and between 1½ and 2 hr to cool the bed after the burner has been cut off. To refill the tower with product, it is only necessary to turn product into the bottom of the tower and vent the gas to atmosphere through the gas eliminator or "stack."

Activated alumina gradually loses its affinity for water with use. New alumina will remove considerably more water than material that has been regenerated many times. Actually the curve of adsorption capacity of the alumina drops rapidly during its first several regenerations and then assumes a more gradual slope toward the end of its usefulness. Fresh alumina can adsorb in excess of 12 per cent of water by weight, but after the initial regenerations the adsorption capacity drops off to approximately 4 per cent. In order to provide a workable factor of safety, the Strouds dehydrator was designed on the basis of 2.5 per cent adsorption. Fig. 3 shows the curve of decline in adsorption capacity of 8-14 mesh alumina.

In July, 1951, it was found necessary to replace the desiccant in two of the towers because it was no longer possible to obtain a 24-hr run through the plant without exceeding the ppm of water permissible in the outgoing product. After replacing the desiccant in two towers, dehydration was accomplished by operating the plant with one tower containing old desiccant and one tower

FIG. 4. Desiccant degeneration through one dehydration cycle.



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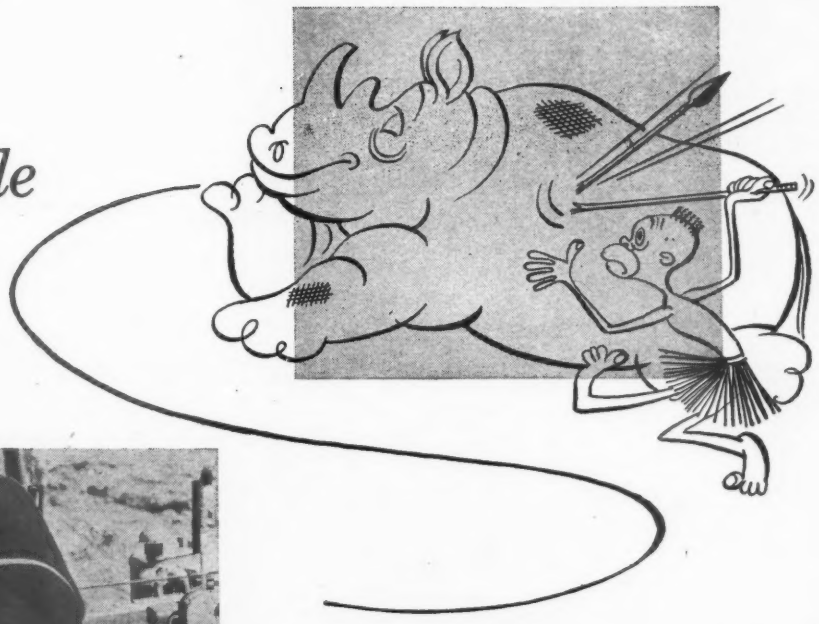

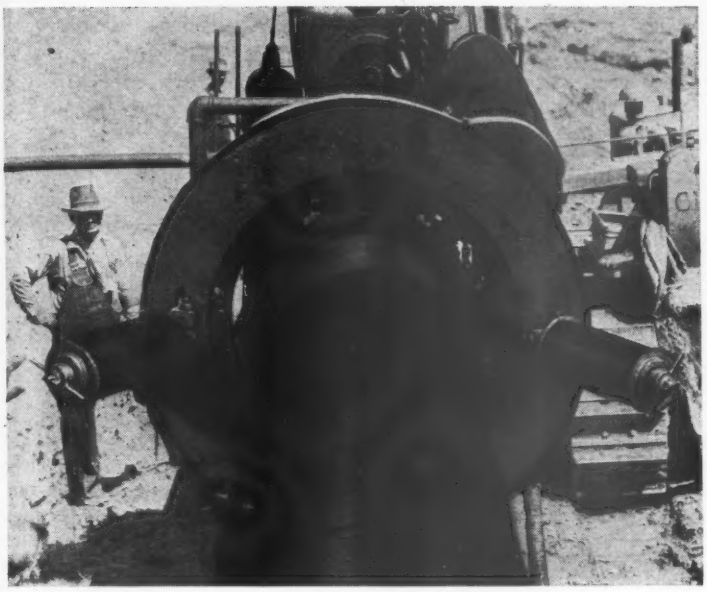

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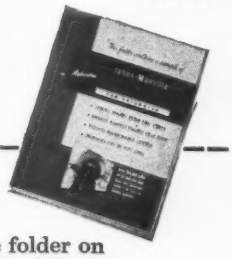

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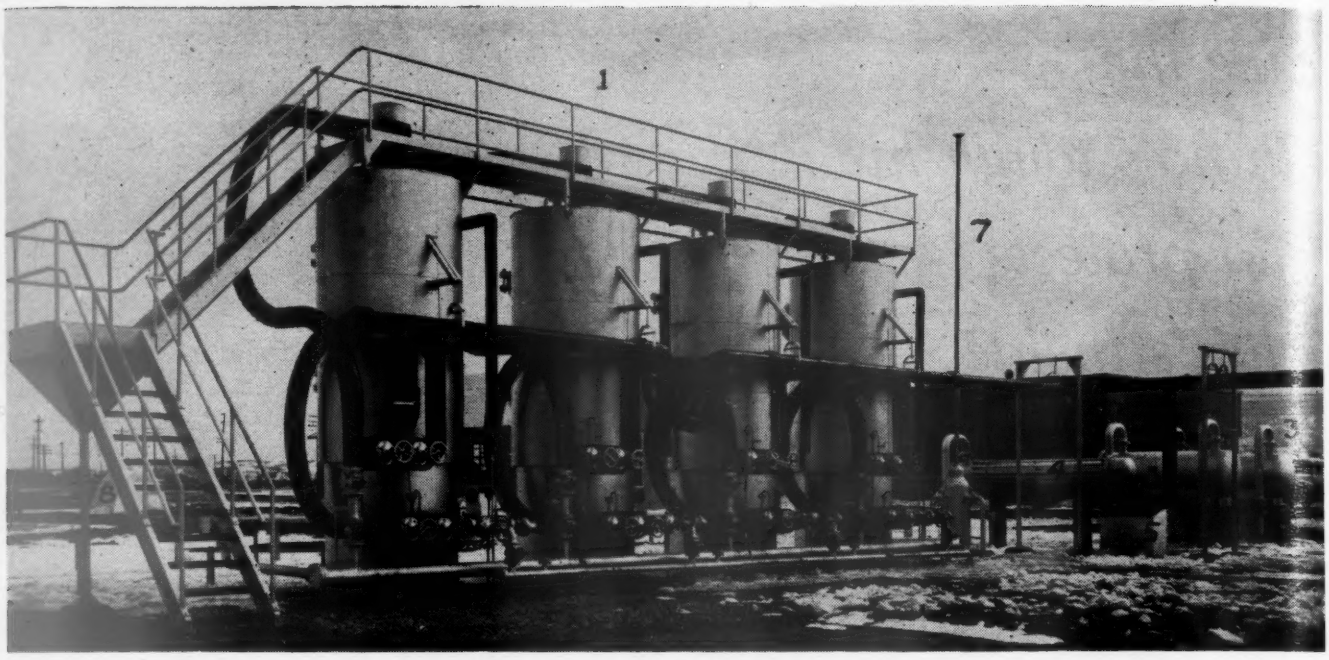


Strouds dehydrator looking southeast.

1—Towers
3—Water separators
4—Heat exchangers
5—Knockout drum
7—Stack
8—Slop settling tank

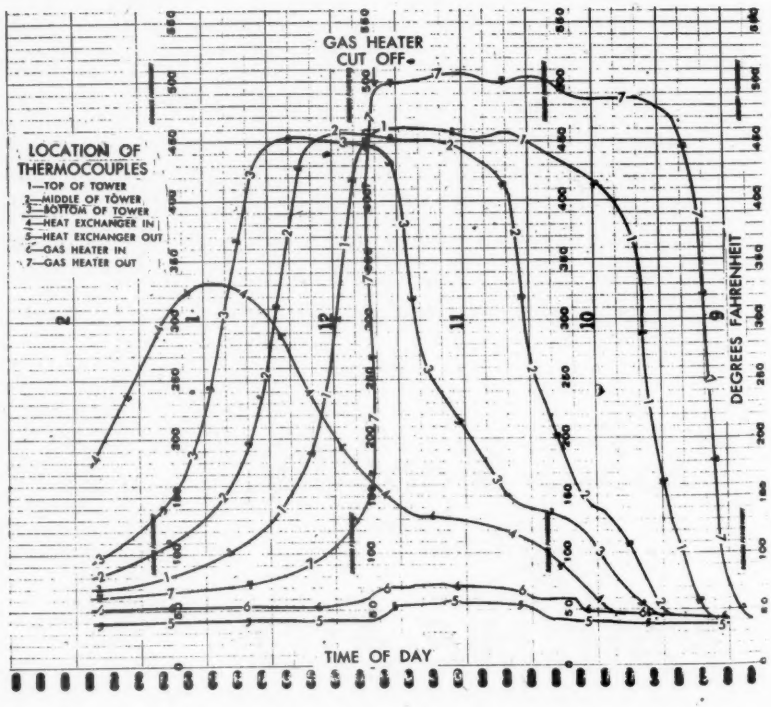
containing new desiccant on stream together. With this method, sufficient water removal was realized to render it unnecessary to change the desiccant in the other two towers.

A typical set of desiccant degeneration curves for a complete dehydration cycle are shown in Fig. 4. The cycle depicted covers a 94-hr run consisting of 54,000 bbl of Housebrand gasoline and 12,000 bbl of Furnace Oil No. 1. During this cycle one tower containing comparatively fresh desiccant and one tower containing "old" desiccant were on stream together. The curves indicate quite clearly that the newer desiccant removes a much higher percentage of water than does the old. Also that the dehydrator removes a higher percentage of water when the product is more nearly water saturated. The Housebrand gasoline received after the tank change noted on the curve had a higher saturation than the first of the batch, and the Furnace Oil No. 1 contained more water than the gasoline. It will be noticed that simultaneous with the batch change to furnace oil, the pumping rate was increased and the effectiveness of the desiccant dropped rapidly. A later reduction in rate, however, permitted the dehydrator to remove more water.

The operation of the dehydrator is essentially manual. The temperature of the heated natural gas thermostatically controlled, and the water separator and knockout drum, by means of float-operated valves, automatically decant the water and water-slop mixture respectively trapped in them, but the rest of the operation must be controlled by the station engineer.

Several protection devices are provided to assure the safety of the operator and the plant. The pilot flame in the gas heater is customarily left burning, but in the event it is extinguished, it is re-lit by means of an electric igniter. A Flame-o-trol controlled solenoid valve cuts off the gas supply to the pilot when the flame is extinguished, and at the same time causes an alarm horn to sound. The solenoid valve on the gas supply to the main burner cannot be opened unless the compressor is running. This assures a flow of gas through the furnace while the burner is lit. This valve will also close if the flame is ex-

FIG. 5. Temperature curves through one regeneration cycle.



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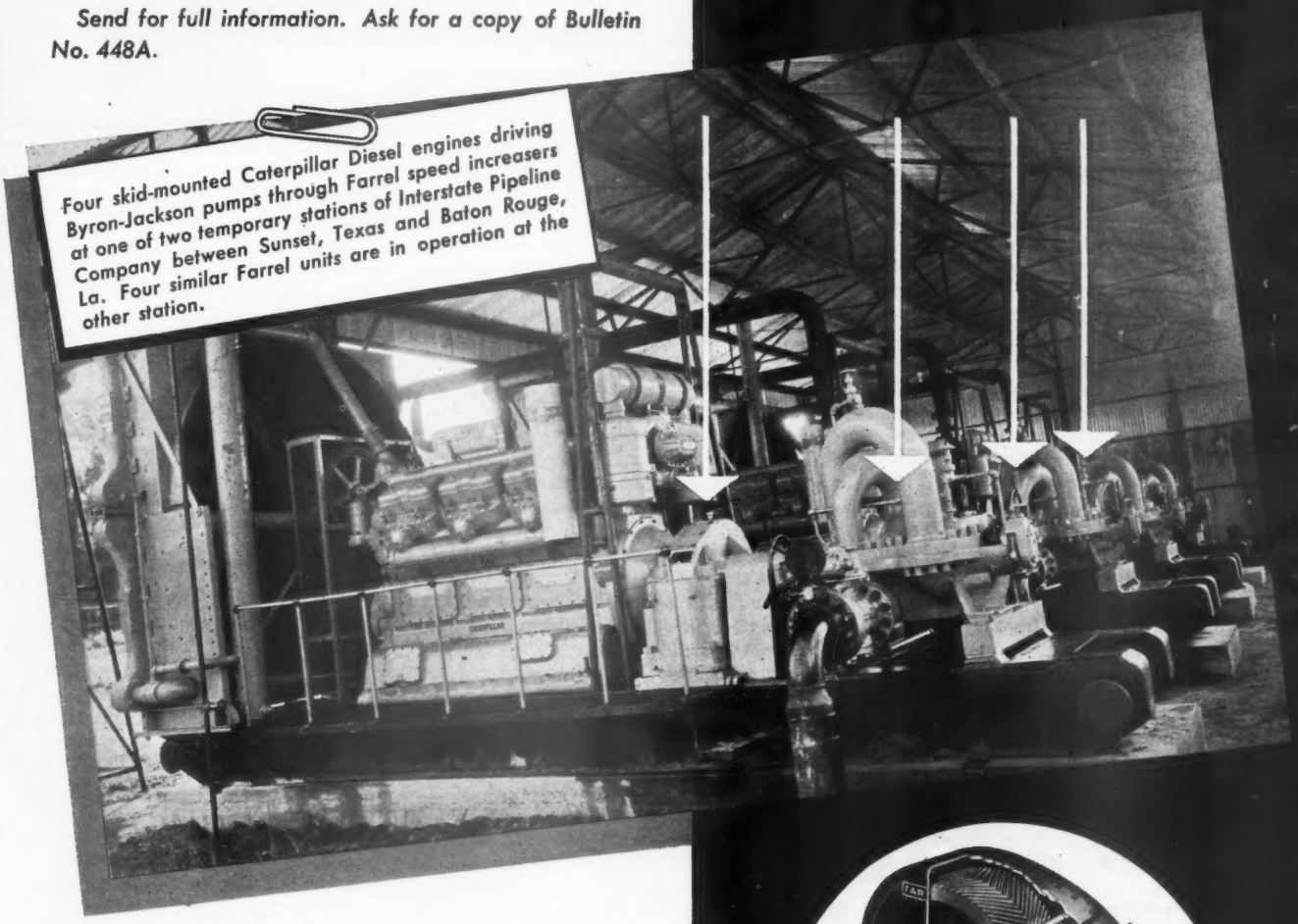
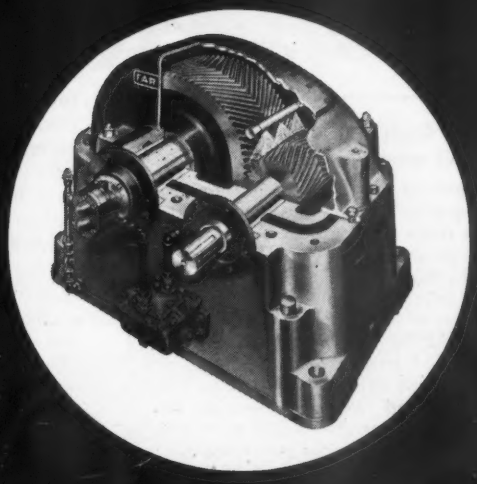


Four skid-mounted Caterpillar Diesel engines driving Byron-Jackson pumps through Farrel speed increasers at one of two temporary stations of Interstate Pipeline Company between Sunset, Texas and Baton Rouge, La. Four similar Farrel units are in operation at the other station.



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tinguished or if the compressor stops. A Limitrol, set at 1000 F is situated in the brickwork high in the furnace and prevents overheating of the furnace by closing the burner valve when the Limitrol thermocouple senses that temperature. The alarm also sounds when the water level in either the water separator or gas-slop separator is too high; when the make-up gas pressure exceeds 95 psi; when the differential pressure across the dehydrator exceeds 30 psi, or when the recycling gas temperature exceeds 515 F.

Temperatures at various points along the gas system are recorded on a Brown electronic strip chart potentiometer, thus enabling the operator to observe the progress of the regeneration cycle. The curves taken from a typical cycle are shown in Fig. 5.

Comparatively few operating difficulties have been encounted in the operation of the Strouds dehydrator. The Wyco line transports seven gasolines, two diesel fuels, two low flash tractor fuels, and three burning fuels for a total of 14 products. During initial operation of the dehydrator, the towers were bypassed during changes from gasolines to oils, and vice versa, and the following product was turned through fresh towers. This was done to minimize interfacial commingling. Also changes from dyed to undyed products were handled in the same manner. Experiments proved, however, that this procedure was unnecessary. We found that the amount of the gasoline-oil interface was increased only 9 per cent at the terminal when the interface was passed through the towers. This increase, which amounts to approximately 15 bbl in gasoline-to-gasoline interfaces and 25 bbl in gasoline-to-refined oil interfaces, has no material effect on the handling of the mixture at the terminals. Furthermore, running interfaces through the towers greatly reduces the number of regenerations required and thus extends the life of the desiccant.

It was also found that, although new desiccant picked up color from dyed products and transmitted it to undyed products, this action ceased after a few regenerations. A somewhat similar condition existed with respects to oxidation inhibitors. Although new desiccant removed some inhibitor, it did not lessen the quantity sufficiently to affect its action. After the desiccant had been regenerated a few times, no effect on the inhibitor was detected.

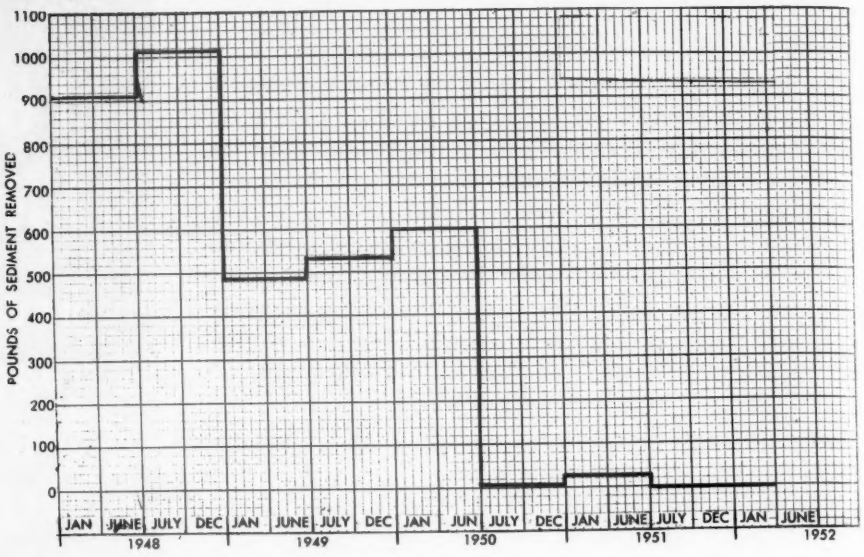

FIG. 6. Wyco pipe line sediment removal in pounds per month.

It was expected that carryover of alumina fines into the line meters during initial operation might cause an undue amount of meter and pump repairs. We found, however, that either the particles carried over were so finely divided that they carried through the meters and pumps without causing any damage, or, at the rates at which we were pumping, a very small amount of fines was carried from the towers, because no difficulty was encountered in this regard.

When the plant was first placed in operation, all valves on the recycling hot gas lines were lubricated plug valves. Unfortunately the high temperature lubricants, with which the valves were originally lubricated, rendered the valves virtually inoperable at the very low temperatures encountered during the winter. Other lubricants, which operated satisfactorily at the low temperature, cooked out when the gas temperature approached 500 F. A great many different lubricants were tried in an effort to find one that would give satisfactory operation from sub-zero temperatures to temperatures around 500 F. None of those tried proved satisfactory and it was necessary to replace these valves with gate valves. The gate valves operated very well for a short time; however, it developed that desiccant fines and carbon were being trapped in the valves in such a way that the valve disks could not be seated properly. To correct this condition we drilled and tapped the bottom of the valves and installed ½-in. blow-down valves so that the line valves could be periodically blown free of fines. Since this was done no further difficulty has been experienced.

Because of the simplicity of operation of the dehydrator, actual attendance by an operator is required only at the beginning and end of the regeneration cycle. Most of the labor charged against the operation consists of general maintenance and the chemist technician's time spent in running titrations. It was not necessary to augment the crew of station engineers to handle the dehydrator.

The dehydration cost per 1000 bbl for the year 1951, excluding depreciation and taxes, was as follows:

Operating cost

Labor	$0.47
Gas and Electricity	.20
Desiccant replacement	.17
Maintenance (materials)	.06
	$0.90 per 1000 bbl

At 20,000 bbl per day designed capacity, the operating cost will reduce to $0.68 per 1000 bbl.

Unfortunately, Wyco's corrosion spools were all in the line during the 2½-year period prior to dehydrating. Consequently, they are now valueless as references for determining the efficacy of the dehydration. Therefore, several scraper runs have been made since the dehydrator was placed on stream, and the results of these runs (Fig. 6) are quite indicative of the protection the dehydrator is giving the line.

Prior to June, 1950, sediment removal averaged 716 lb per month for 2½ years. Since that date, sediment removal has averaged 9 lb per month; however, during the last nine months scraper runs have brought in no sediment whatsoever. We now contemplate running scrapers only once or twice a year for the purpose of checking the line.

A second titration apparatus will shortly be installed at Denver for the purpose of observing the wetness of products received from the line at that point. When this procedure is in effect it will be possible to determine whether dehydration is completely effective for the entire length of the line. Results of line-end tests also are expected to indicate whether dehydration cycles can be extended or must be shortened for full line protection. * * *

Third Quarter Allocations To Oil and Products Lines

Petroleum Administration for Defense has granted priority assistance to 12 large crude oil pipe lines and 11 large products pipe lines in the United States for the third quarter of 1952. These 23 large lines will require a total of 227,285 tons of line pipe.

In addition, PAD allocated to a large number of smaller projects—crude oil and products lines, terminals, small construction, and MRO (maintenance, repair, and operation)—a total of 44,466 tons of line pipe for the third quarter.

Estimated construction cost of the 23 large projects is $193,424,000.

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Panhandle Eastern Pipeline Company (telemetering)

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To obtain more information on products advertised see page E-51

GREATEST OIL PIPE LINE YEAR*

PAD has approved projects totaling 10,000 miles for 1952 —materials situation should be easier after September

JOHN E. BOICE

More than 19 months have passed since Congress, moved by the new Communist threat that was underlined with the invasion of the Republic of Korea, passed the Defense Production Act of 1950. It has been almost as long since Secretary of the Interior Oscar L. Chapman, acting on delegated authority from the President, established the Petroleum Administration for Defense on October 3, 1950.

PAD fits into the overall mobilization program because, as two world wars have proved, oil is almost literally ammunition.

The agency has had to hurdle many obstacles during its relatively short life, solving problems that have ranged from a shortage of aviation fuels for the military back in 1950 to a shortage of fuel oil on the East Coast in the months just past.

The Supply and Transportation Division has been fortunate in having had as its directors on a rotating basis such qualified industry leaders as Dean Hodges, vice president of Shell Oil Company; George A. Wilson, president of Interstate Natural Gas Company, and now Charles E. Spahr, vice president of Standard Oil Company (Ohio). Their industry experience ably qualified each to take over the responsible position of directing supply and transportation.

First of the division's problems was posed by the Nation-wide railroad switchmen's strike in late January and early February of 1951. The situation was particularly bad because barge movements at the time were blocked by frozen rivers, and tank-truck movements were slowed by icy highways. PAD established a temporary district office in Chicago and helped distribute the available heating oil to relieve distress. Fortunately the strike was a short one, but it still took several weeks to restore normal transportation.

The second problem was that of providing additional tanker tonnage to meet military requirements. That was solved after tanker owners and operators agreed to set up a voluntary tanker pool to be operated by the United States Maritime Authority, with each owner or operator making available his prorata share of the military needs at rates 25 per cent above the World War II rates set by the Maritime Commission. This plan is still in operation.

From that point forward the problems multiplied quickly.

The dispute over nationalization of Iranian oil and the subsequent closing down of the refinery at Abadan on the Persian Gulf, the world's largest refinery, had repercussions throughout the free world. Much of the crude oil normally imported from the Middle East to the eastern section of the United States and Canada had to be diverted to Western Europe. That meant more crude had to be shipped from the Gulf to East Coast refineries, and that in turn meant that pipe lines from interior points in Texas and Louisiana had to be increased in capacity or rearranged to handle the increased demands.

Rising military demands for oil on the West Coast became so great that California refineries, faced with a shortage of crude, could not meet them. It became necessary to pick up a large percentage of the refined products for offshore movement from the Gulf Coast to avoid disruption of civilian activities on the Pacific Coast.

Then the East Coast came up with its problem. Disparities between ceiling prices on the East Coast and those on the Gulf threatened a fuel oil shortage. Tanker charter rates had risen so much that shipments from the Gulf had become uneconomical. The Office of Price Stabilization, however, refused to increase the East Coast ceilings to alleviate the condition. Finally, at the request of PAD, 12 oil companies entered into a voluntary agreement to transport and distribute 1,648,000 bbl of kerosine and fuel oil for resale on the East Coast at our direction. Participants in this cooperative pool suffered a considerable financial loss for which they cannot be reimbursed, but at least the East got through the winter.

All these special problems are in addition to the continuing one of trying to oversee equitably the necessary expansion of the Nation's transportation system for petroleum at a time when essential materials are in short supply.

The handling of some 350 applications for accelerated tax amortization on pipe line and terminal storage projects whose aggregate cost of construction is more than $970,000,000 has consumed much of the time of the small supply and transportation division staff. Each of the applications has had to be carefully analyzed, and separate letters of justification must be prepared for every one that is approved. Ground rules for processing these applications have been changed often since the processing began. Each change has called for further review, and a rewriting of the recommendations.

Eight specialists, all consultants to PAD, completed in mid-1951 a comprehensive, detailed study of the transportation of oil[1]. The study covers facilities for the movement of petroleum by pipe line, tanker, barge, tank car, and tank truck, and also estimated storage needs. It sets out an inventory of these facilities as they existed in 1951 and indicates the need for new facilities through 1952 to keep abreast of the anticipated increase in production and refinery expansion. The study also contains estimates of probable yearly demands and other forecasts through 1955. This study has proved invaluable to the Supply and Transportation Division—and to many other Government agencies—in making many decisions on accelerated tax amortization and other matters. It contains considerably more detail than the somewhat similar studies completed in 1949 and 1950 by the National Petroleum Council.

Undoubtedly the most troublesome function of the Supply and Transportation Division has been the handling of matters connected with the Controlled Materials Plan, which govern the use of steel, copper, and aluminum.

Ever since July 1, 1951, effective date of CMP, PAD has been claiming the portion of these scarce materials that should go to the oil and gas industries. It is the Defense Production Administration, though, that controls the mate-

*These remarks by Mr. Boice, special assistant to the director, Supply and Transportation Division, Petroleum Administration for Defense, were made before the American Petroleum Institute Conference on Products Pipe Line Technology, Fort Worth, Texas, April 21, 1952, under the title "Keeping Oil Flowing for National Defense."

[1]Copies of the report, titled "Transportation of Oil," contain 118 pages and 32 charts and maps. They are available from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., at a cost of $1.75.

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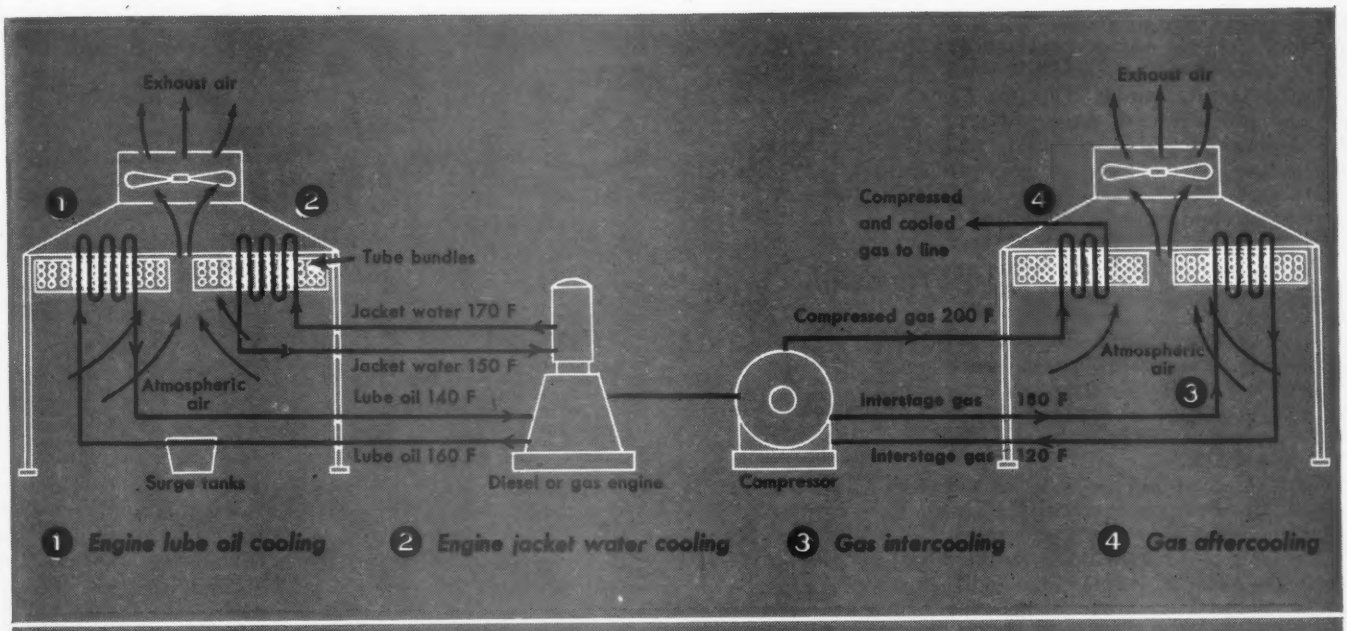

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rials overall. We are merely a claimant agency for a piece of the whole pie. Our estimated quarterly materials requirements are considered along with what the military and other Government agencies claim, what the many defense-supporting industries and thousands of small manufacturers need. When these total needs are determined, they usually add to substantially more than the available supplies. Then DPA brings out the knife, and PAD's piece of the pie, like that of many other claimants, is usually cut thin, often far below actual needs. For instance, PAD estimated it needed 8,121,982 tons of carbon steel for the oil and gas industries during the 12 months beginning July 1, 1951, and ending June 30, 1952. We are given allotments of only 6,245,485 tons, or 77 per cent of requirements.

As the overall allotments have been small, the portion that each of the operating divisions within PAD gets for distribution also have been small. Supply and Transportation has suffered particularly, because of course the greatest need in pipe line construction is for line pipe, and that pipe has been in very tight supply as a result of the shortage of plate steel.

The building of oil pipe lines has had to be in direct competition with the laying of thousands of miles of gas transmission and distribution lines. Furthermore, the United States pipe mills have produced a large part of the pipe laid in foreign areas. These factors, too, have tended to reduce the amount of materials Supply and Transportation could assign to the building or domestic pipe lines for oil.

A recent summary shows that a total of 2,435,370 tons of line pipe were allocated by PAD during the last half of 1951 and the first half of 1952 for laying oil and gas lines. Of the total 870,447 tons went to oil lines and 1,564,923 tons to gas lines.

There were good reasons in both economics and defense requirements for this almost two-to-one ratio in favor of gas lines. The gas industry had embarked on a huge expansion program long before the defense program was begun, and it deserved to be permitted to continue its expansion. More than that, it was essential to get down as many lines as possible to places like the Appalachian area and the Chicago area to insure that defense industries would get their needs and home would be kept warm during the winter. Yet the fact remains that oil transportation did suffer somewhat in the sharing on the pipe.

Almost from the start of the rearmament period there has been a need for additional oil pipe line outlets, particularly from West Texas and Wyoming to keep pace with the rise in crude production. There also existed a demand for greater pipe line capacity through Oklahoma and Kansas to serve the enlarged capacity of refineries in the Great Lakes area. More gathering lines were needed to move the crude made available from new wells. New products lines had to be built and existing lines enlarged, extended, or increased in capacity to handle the increased output of refined products from refineries.

Major Crude Oil Pipe Lines to Be Completed in 1952.

Owner	Location	Mileage	Size of pipe, in.	Capacity, bbl per day	Estimated cost
Platte Pipe Line Co.	Wyoming to Wood River, Ill.	1,080	16, 20	70,000	$59,000,000
Service Pipe Line Co.	Drumright, Okla. to Sugar Creek, Mo.	50	12, 16, 20	38,600	3,993,140
West Texas Gulf Pipe Line Co.	West Texas to Gulf Coast and Longview, Tex.	577	20, 26	301,000	39,672,032
Sinclair Pipe Line Co.	Drumright, Okla. to Chicago, Ill.	683	22, 24	280,000	51,942,000
Ohio Oil Co.	Sheridan, Ind. to Lima, Ohio	117	22	180,000	19,727,185
Shell Pipe Line Co.	Gohlke to La Grange, Texas	64	8	15,000	3,211,450
Service Pipe Line Co.	Freeman to La Platte, Mo.	30	20	17,000	2,842,900
Continental Pipe Line Co.	Rincon to Port Isabel, Texas	105	8	17,000	1,935,000
Texas Pipe Line Co.	Louisiana to Port Arthur, Texas	319	10, 12, 22	167,000	18,717,430
Shell Pipe Line Co. (Rancho)	McCamey, W. Texas to Houston, Texas	463	24	209,000	41,593,000
Texas Pipe Line Co.	Corsicana to Houston, Texas	175	16	60,000	7,878,600
Cities Service Pipe Line Co.	Sour Lake, Texas to Lake Charles, La.	6	18	150,000	3,100,000
Continental Pipe Line Co.	Wichita Falls, Texas to Ponca City, Okla.	127	12	40,000	4,200,000
Interstate Oil Pipe Line Co.	La. points to Baton Rouge	102	4, 16	22,000	6,480,000
Gulf Refining Co. (Mesa)	Midland to Colorado City, Texas	80	24	260,000	5,658,575
Interstate Oil Pipe Line Co.	Southwest Louisiana	126	4, 16	35,000	5,610,000
Texas-Empire Pipe Line Co.	Wilmington to Lockport, Ill.	29	18	69,000	1,546,148
Interstate Oil Pipe Line Co.	Bunkie to Melville, La.	33	20	107,000	1,445,000
Service Pipe Line Co.	Bowie, Texas to Drumright, Okla.	33	16	28,000	1,980,000
Pasotex Pipe Line Co.	Wink to El Paso, Texas	200	8	40,000	3,283,390
Interstate Oil Pipe	Flora to Bunkie, La.	63	12, 16	107,000	2,935,000
Toronto Pipe Line Co. (Sterling)	Sterling, Colo. to Curley, Nebraska	115	12	60,000	2,200,891
Humble Pipe Line Co.	Hawkins to Baytown, Texas	201	12, 18	66,000	8,141,000
Ohio Oil Co.	Lima to East Sparta and Newark, Ohio	214	10, 12	25,000	3,936,000
	Major Products Lines To Be Completed				
Tuscarora Oil Co.	Allentown to Midland, Pa.	74	6, 10, 12	45,000	8,398,000
Phillips Petro. Co.	Borger, Texas to Chicago, Ill.	933	8, 10, 12	32,700	20,883,450
Standard Oil Co. (Ind.)	Neodesha to Sugar Creek, Mo.	125	8	12,000	3,707,100
Shell Oil Co.	Wood River to Chicago and Detroit	554	8, 14	85,000	15,850,000
Phillips Oil Co.	Sweeny to Freeport, Texas	27	12	115,000	1,502,000
Ohio Oil Co.	East St. Louis, Ill. to Indianapolis, Ind.	255	8, 10	14,000	2,893,000
Buckeye Pipe Line Co.	Linden, N. J. to Allentown, Pa.	75	16	80,000	6,792,000
Bell Oil & Gas Co.	Ardmore to Drumright, Okla.	145	6, 8	9,000	3,271,396
Standard Oil Co. (Ind.)	Sugar Creek, Mo. to Dubuque, Iowa	316	12	40,000	10,430,000
Susquehanna Pipe Line Co.	Fostoria to Randolph, Ohio	125	6, 8	19,200	3,095,000
Phillips Petroleum Co.	Odessa to Borger, Texas	104	8	8,000	2,728,800
Phillips Pipe Line Co.	Okmulgee to Tulsa, Okla.	35	6	12,000	566,400
Sinclair Pipe Line Co.	Sinclair, Wyo. to Salt Lake City, Utah	310	6, 8	12,000	7,839,849
Salt Lake Pipe Co.	Salt Lake City, Utah to Boise, Idaho	329	8	17,000	8,000,000
Standard Oil Co. (Ohio)	Toledo, Ohio	15	6	9,500	987,000
Vickers Petroleum Co.	Potwin to El Dorado, Kansas	13	8	16,500	400,000

The following statistics will reveal the huge task confronting the Supply and Transportation Division. As the allocation and priorities powers for oil and gas were delegated to PAD, this division alone has received more than 750 project applications to build oil pipe lines and storage terminals with a cost aggregating more than $1,000,000,000. A breakdown shows the cost of pipe lines to be built totals $930,000,000, while $142,000,000 represents the cost of terminals. The applications received covered material needs for the erection of 63,000,000 bbl of oil storage.

Because of the shortage of materials, priorities assistance had to be confined to those projects most urgently needed to support the mobilization program. Each project application received is carefully scrutinized by highly trained and experienced technical assistants and screened to reduce or substitute materials wherever possible. Consideration has also been given to geographical areas in selecting and timing the start of projects. Priority is given to those jobs that can be carried forward during months when construction work can proceed without severe weather interruptions.

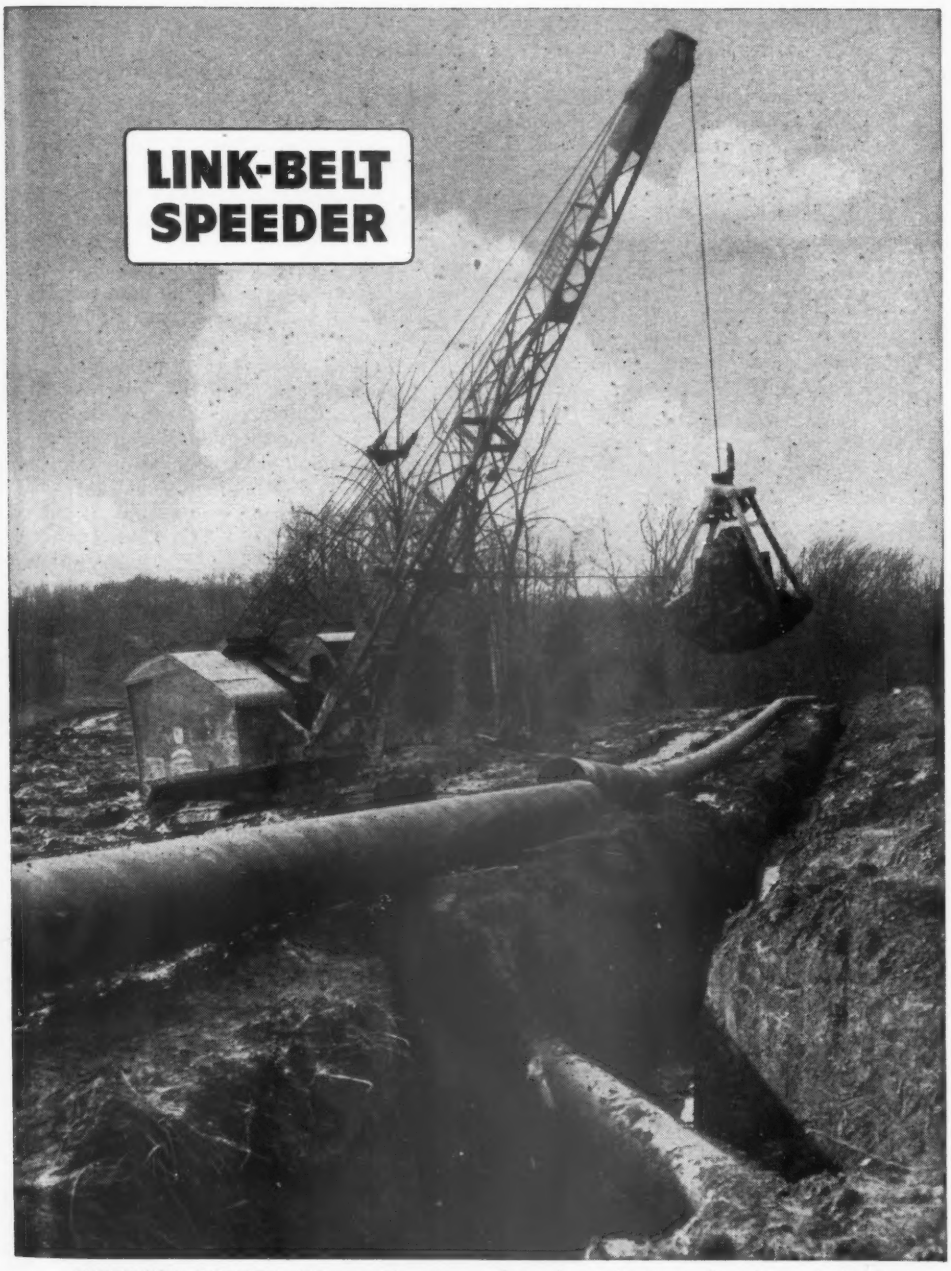
One of the first major programs to receive our attention was that of providing additional storage at 23 frozen-in points in 8 states along the rivers and the Great Lakes. These areas have always been difficult to supply from a transportation standpoint after the close of navigation. With tank cars generally in short supply, it was deemed advisable to augment available storage to permit greater accumulation of products during the open season in order to meet peak winter demands. We authorized the construction of more than 3,000,000 bbl of storage under this program, and it is expected that all tanks not already completed will be erected and filled before cold weather sets in this year.

Although the Controlled Materials Plan was inaugurated on July 1, 1951, it did not become fully operative until after the fourth quarter of 1951. Many of the allocations for pipe and plate steel made by PAD in the third and fourth quarters have had to be revalidated to later periods because of the inability of companies to obtain the materials when authorized. In other words, the early operation of the CMP was more or less in the nature of a "shakedown cruise," or a period of chaos and dislocation. During this period of confusion a pun frequently heard was "Original allocations never die, they simply fade away." Figures released by the American Iron and Steel Institute show the production of line pipe in 1951 was 481,000 tons, or 15 per cent less than was produced in the year of 1950, notwithstanding the greater needs during the rearmament period. DPA admits that in the earlier quarters of CMP it deliberately issued more "tickets" for material than supply warranted on the assumption that some allotments would not be used.

Despite all the early difficulty and confusion in obtaining materials, the situation has clarified and 1952 will witness, barring unforeseen circumstances,

Combines power and stability

LS-85 licks the pipeliner's toughest problems



MORRISON CONSTR. CO., Austin, Texas, depends on the heavy-duty ¾ yard LS-85. This brute is popular because boom changes can be made quickly in the field . . . sturdiness prevents down-time . . . and the LS-85 has the power pipeliners demand (its diesel engine delivers 92 net h.p. at full load speed).

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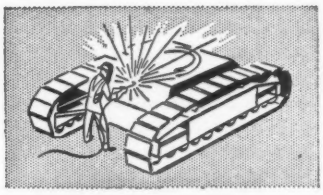

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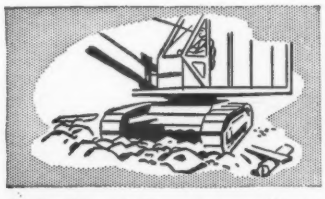

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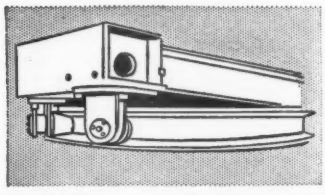

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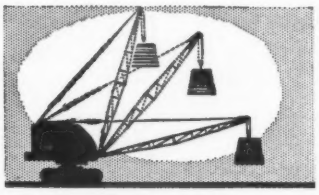

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the greatest oil pipe line construction activity in history. The Supply and Transportation Division has thus far approved projects calling for the laying this year of more than 10,000 miles of important petroleum lines, including about 6500 for moving crude oil and 3500 for transporting refined products. Work on some of the projects authorized has already begun, while others will go forward promptly upon the delivery of pipe. The major crude oil systems expected to be completed this year include the 20, 24, and 26-in. West Texas Gulf Pipe Line extending 657 miles from Midland, West Texas, to the Gulf Coast; the 24-in. Rancho Pipe Line extending 463 miles from McCamey, West Texas, to Houston; the 16 and 20-in. Platte Pipe Line extending 1080 miles from Wyoming to Wood River, Illinois; the 22 and 24-in. Sinclair Pipe Line extending 683 miles from Drumright, Oklahoma, to Chicago, Illinois, and the 22-in. Texas Pipe Line extending 319 miles from Louisiana Gulf Coast to Port Arthur, Texas.

In the products pipe line field, Phillips Pipe Line Company is completing the work of laying 933 miles of 8, 10, and 12-in. loops on their line from Borger, Texas, to Chicago; Shell Oil Company will relay its Wood River to Chicago line with 14-in. pipe and probably extend it to Detroit, a total distance of 565 miles; Standard Oil Company (Indiana) will build a new 316-mile, 12-in. line from Neodesha, Kansas, via Sugar Creek, Missouri, to Dubuque, Iowa; Ohio Oil Company will lay 255 miles of 8 and 10-in. lines between East St. Louis, Illinois, and Indianapolis, Indiana; Buckeye Pipe Line Company will lay a 75-mile, 16-in line from Linden, New Jersey, to Allentown, Pennsylvania, and probably extend the system later some 282 miles with 10 and 14-in. pipe into upper New York State; Pioneer Pipe Line Company will lay a 310-mile, 6 and 8-in. line from Sinclair, Wyoming, to Salt Lake City, Utah; the existing Salt Lake Pipe Line extending from Salt Lake City, Utah, to Pasco, Washington, will be looped with 329 miles of 8-in. pipe as far north as Boise, Idaho. Texas Pipe Line Company plans to lay a new 198-mile 16-in. line from Port Arthur, Texas, to Baton Rouge, Louisiana, which will be connected by an 85-mile, 12-in. line from Houston to Port Arthur, to be laid by Sinclair Pipe Line Company. Other products lines expected to be built this year are still under consideration. A list of the principal oil lines to be built and expected to be completed by the end of this year is appended to my statement. This year will also see the conversion of many miles of crude lines to products service.

The mileage of oil pipe lines actually completed and placed in commercial operation during 1951 was considerably less than the average built in other postwar years. Only 2866 miles of principal lines were completed and placed in service last year, including 1463 miles of crude lines and 1403 miles of refined products lines. The major lines built were in the Ohio Oil Company's 237-miles, 20 and 22-in. crude line from Wood River, Illinois, to Sheridan, Indiana; Service Pipe Line Company's 123-mile, 10-in. crude line from Jud to Bowie, Texas; Gulf Oil Corporation's 152-mile, 10 and 14-in. crude line from Eucutta and Lamberton, Mississippi, to Mobile, Alabama, extension of Phillips-Shamrock's 155-mile, 6-in. products line from La Junta to Denver, Colorado; replacement of about 329 miles of Tuscarora's products line with 10 and 12-in. pipe between Tuckerman and Midland, Pennsylvania. Great Lakes Pipe Line Company's products line from Des Moines to Iowa City, Iowa, was looped with 107 miles of 8-in. pipe, Pure Transportation Company built a 100-mile, 6-in. products line from Heath to Dayton, Ohio. A 190-mile, 6-in. products line from Searsport to Limestone, Maine, was built by the United States Engineers, and Plantation Pipe Line Company built a 707-mile, 14-in. and 18-in. line paralleling their existing products system between Baton Rouge, Louisiana, and Charlotte, North Carolina.

The average mileage of petroleum pipe lines built during the five postwar years, 1946 to 1950, was 2213 miles for crude movement and 1612 miles for transporting refined products, or a total of 3825 miles, compared with 2866 miles completed in 1951:

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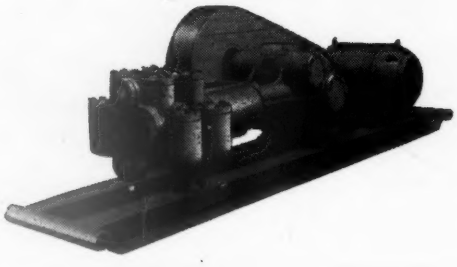

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Year	Crude	Products	Total
1946	888	1,880	2,768
1947	869	2,131	3,000
1948	2,278	1,246	3,524
1949	3,916	928	4,844
1950	3,115	1,875	4,990
Total	11,066	8,060	19,126

The progress of completing oil pipe lines in 1951, however, is considered phenomenal in light of the scarcity of materials. The results achieved are due largely to the oil pipe line companies' ingenuity in finding ways and means of helping themselves. The mileage of lines completed would have been considerably less had it not been for the use of a large percentage of second-hand and foreign manufactured pipe.

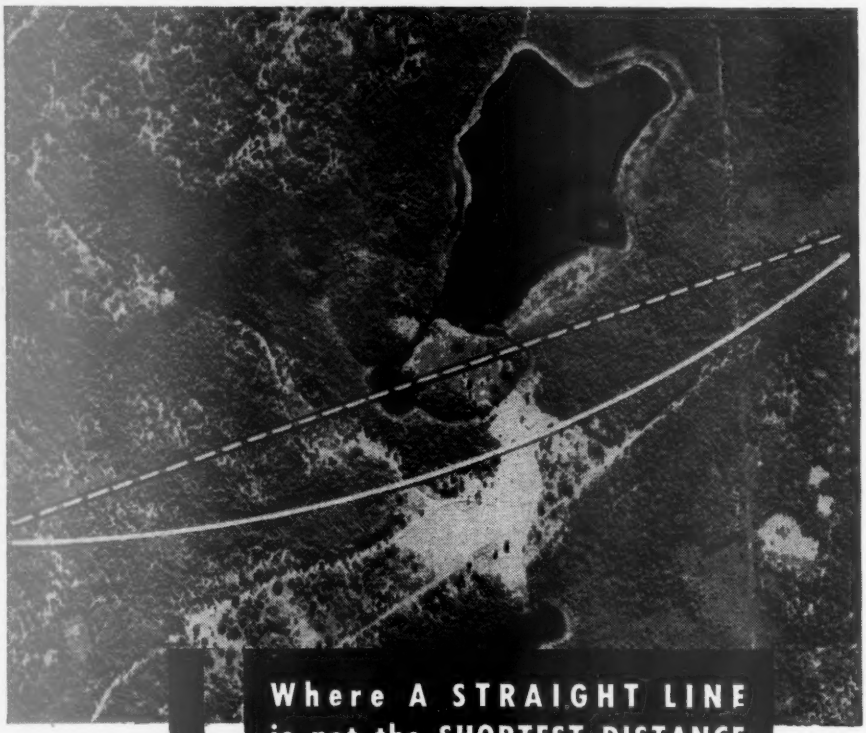
The trend established during World War II of constructing large-diameter oil pipe lines with wide station spacing has paid off during the present mobilization period. For instance, on the Basin, Ozark, and Mid-Valley systems — all crude lines completed the past few years—a substantial increase in capacity was made available with a small expenditure of critical materials by constructing intermediate booster stations. The Planatation products line is also being enlarged by adding booster stations to provide greater pipe line capacity.

None of the oil pipe lines is being built at Government expense as was necessary during World War II. Industry has financed the construction of the entire program either from earnings or borrowed capital. Furthermore, PAD has found it unnecessary to issue directives or to otherwise interfere with normal industry operations. Any changes necessary to bring about greater pipe line flow of oil have been achieved by means of industry-government cooperation. It is our desire to keep it on that plane. There have been some cases in which the Supply and Transportation Division has been forced to deny applications to conserve materials where pipe lines to be built would duplicate existing lines. In one or two cases where different companies were competing to construct pipe lines to serve the same area, the final result has been the building of a jointly owned line.

PAD's philosophy concerning the allocation of controlled materials was ably stated by A. P. Frame, former Assistant Deputy Administrator, when he testified before the Select Committee on Small Business of the House of Representatives on February 27, 1952, on the method of distributing oil country tubular goods.

> "What I have to say applies generally, not only in the field of oil production but in all other phases of the oil and gas industries. We conceive PAD as a purely temporary agency, created to assist the Secretary of the Interior in discharging the responsibilities delegated to him under the Defense Production Act. We conceive our duty to be that of making a fair and equitable allocation of scarce materials to units of the industry with a minimum of disturbance of the competitive pattern that existed when controls were first imposed. Our fondest hope is that when PAD is dissolved we will have interfered not at all with normal competitive forces. We conceive of ourselves as umpires, not as dictators."

Prior to the Korean outbreak this country had adequate pipe line capacity and perhaps a little to spare. The crude oil lines during the first 6 months of 1950 were delivering to refineries an average of 3,986,000 bbl per day of raw material; products lines were delivering 1,023,000 bbl per day of light refined oils to terminals close to points of consumption. Since then has been seen a progressive increase in production and refinery operations unparalleled in history. Statistics show that thousands of new wells have been drilled and production of crude oil has increased from 5,378,000 bbl per day in June 1950 to about 6,400,000 bbl per day at present. During this same period refinery runs have mounted from 5,655,000 to about 6,700,000 bbl per day. Likewise, total demands for all oils rose from 6,334,000 to 7,152,000 bbl per day. As a result of these unprecedented activities the pipe lines have been called upon to keep pace with the increased requirements. Recent figures show that crude oil lines are now delivering 4,921,000 bbl per day to refineries, a 23 per cent increase over the first half of 1950, while products lines are delivering 1,386,000 bbl per



Section of an Abrams Aerial Mosaic: Scale 1"=1000'.

Where A STRAIGHT LINE is not the SHORTEST DISTANCE

On this aerial photograph the dotted line shows where a proposed pipeline would have been routed using conventional maps. The solid line shows the actual route based on an Abrams Aerial Mosaic. Aerial photography instantly showed that bending the line would eliminate crossing a stream, expensive resort property and a small lake —that, measured in time and money, a straight line here was not the shortest distance. Save your time and money; use Abrams Aerial Surveys to show you the shortest practical routes for your pipelines.

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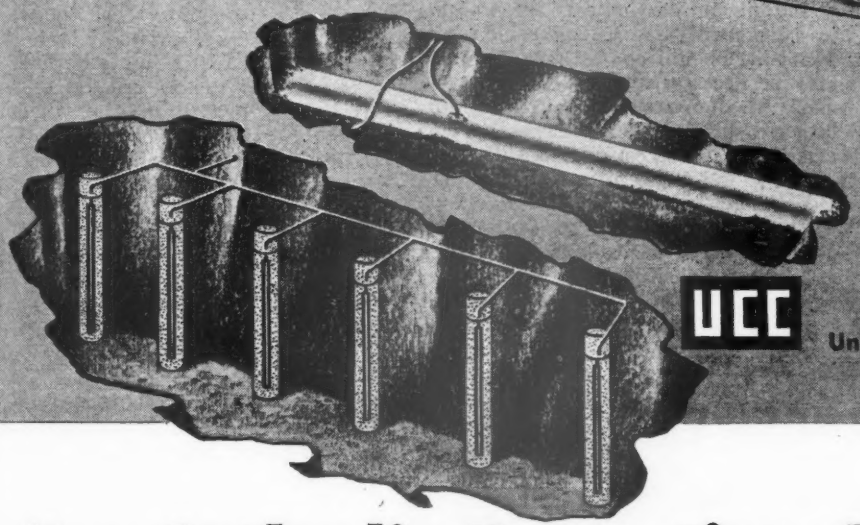

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day to terminals, or 35 per cent more than prior to Korea.

The shift in movements of petroleum from the railroads to pipe lines is especially noticeable. Products pipe lines are now delivering 28 per cent of the total domestic demand for light products—gasoline, kerosine, and distillate. Pipe lines are the second largest ton-mile mover of all commodities transported domestically on land or sea, being surpassed only by the railroads. In the movement of petroleum alone, however, the pipe lines rank first over water, rail, or highway carriers. Federal tax collections on pipe line transportation form a good indicator in determining the increase or decrease in petroleum movements. As you are probably aware, the tax is 4½ per cent of the transportation charge. During the year 1949 the tax collected amounted to $18,765,000; in 1950 it was $21,875,000 and rose to $25,512,000 in 1951. Although pipe line tariff rates have remained rather uniform, the tax collected increased more than 16 per cent in each of the last two years.

PAD has recently supplied the Defense Production Administration a forecast of what facilities the oil industry can be expected to build during the last 6 months of 1952 and during the 12 months of 1953. This program calls for drilling 80,000 wells to increase crude production 642,000 bbl per day, adding 750,000 bbl of refinery capacity, laying 19,700 miles of petroleum pipe lines, and erecting 153,000,000 bbl of new storage tanks. The purpose of setting up this goal is to get materials for a program that industry has shown it could and would undertake. The program recently approved by DPA covers normal expansion under present mobilization planning and is not aimed at providing enough reserve to meet demands in the event of all-out war.

PAD's control over petroleum transportation lies only in the field of pipe lines. The Office of Defense Transportation has jurisdiction over inland waterway equipment, tank cars, and tank trucks, while the Maritime Administration has ocean tankers. Our dealings with these two agencies have been most harmonious, and through close cooperation many important problems have been solved.

At present it is extremely difficult to place orders with pipe mills for pipe 8-in. diam and below. The future needs of the oil and gas industry for pipe in this range will be great, and some readjustments of mill operations will probably be necessary. The replacement of many small-diameter pipe lines with larger lines, however, is expected to make available a considerable tonnage of 8, 10, and 12-in. pipe. Much of this second-hand pipe will be re-usable and will go into secondary trunk or main discharge lines, thus relieving the strain to some extent on requirements for new pipe.

The industry presently is also having difficulty in placing orders for lightweight, thin-wall pipe and has been forced to obtain additional tonnage of steel from PAD in order to meet specifications applicable to standard weight pipe. This in my opinion is a waste of critical steel. The extra tonnage of steel we are forced to give out from our small allotments to satisfy the requirement for standard weight pipe could well be used toward starting other projects.

The following statements are the author's personal observations, which should not be construed in any way as expressing the opinion of PAD:

The materials situation will ease after this September the author believes. The enlargement of steel mill capacity, along with the spreading out of the preparedness program over a longer period than originally planned, will prove beneficial to the domestic economy by making more materials available for civilian consumption. The need for building any more unusually large long-distance crude petroleum pipe lines except possibly a new crude line from West Texas to California, or an outlet from the rapidly developing Williston Basin of North Dakota, cannot be foreseen. The author anticipates a slow down in the construction of large, long-distance natural gas transmission lines. A big line to bring gas from Alberta, Canada, to the Pacific Northwest is definitely in the making and will probably be constructed next year along with one or more lines now awaiting approval of the Federal Power Commission. Many pipe lines, both oil and gas, will be built in the near future, but they will be more in the nature of smaller-diameter crude gathering lines to tap expanding production areas such as Spraberry in West Texas, the Williston area, or in the Uintah Basin of Utah, products lines, or lines for natural gas distribution.

Oil pipe lines have proved their value in peace and war, and the expansion taking place during the mobilization period will vastly increase capacity for transporting the larger quantities of oil to meet military and civilian needs. Barring strikes or restrictions on essential materials and manpower, the industry can be relied upon to keep the oil flowing for defense. * * *

6000 Miles of Pipe Line Completed in U. S. in 1951

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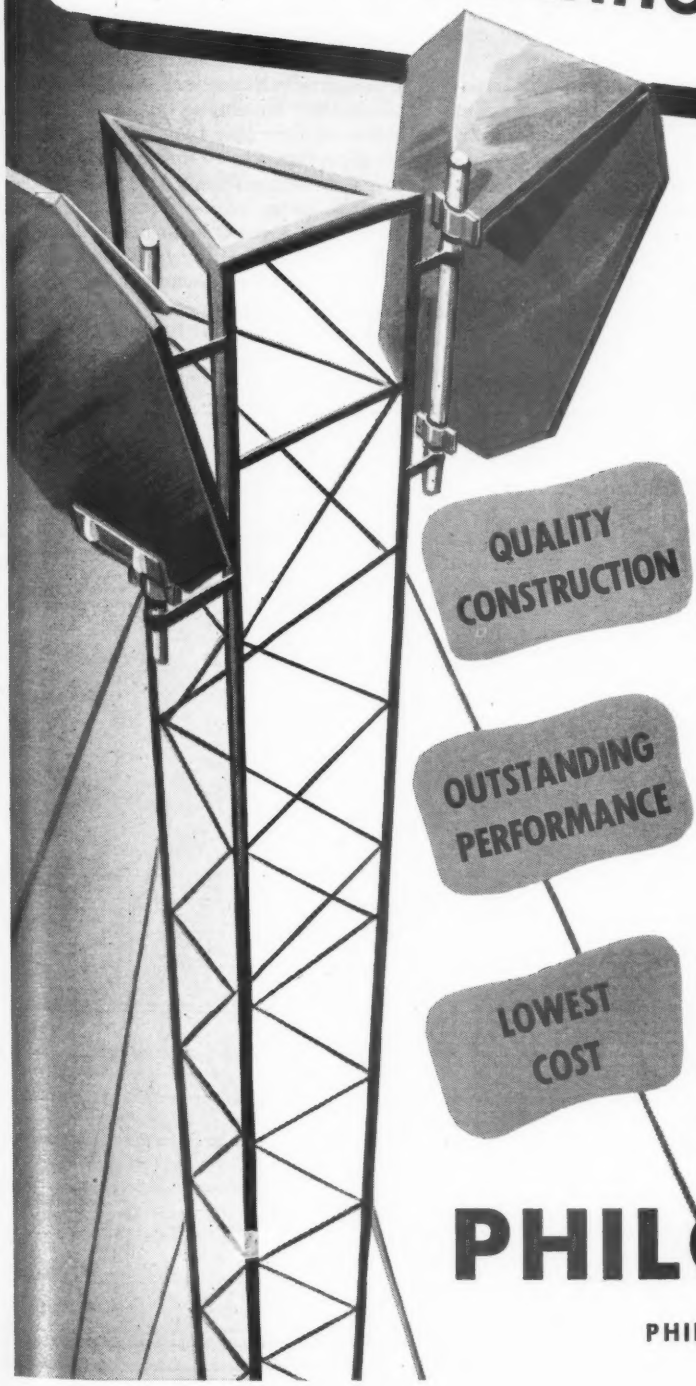

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Brazilian Pipe Lines Near Completion

Parallel 10 and 18-in. products lines between Santos and Sao Paulo will serve important industrial center

MANUEL DA SILVA*

BRAZIL's heavily overtaxed transportation system will have one important load taken from its back when the new Santos-Sao Paulo pipe line is inaugurated in a few weeks.

No part of the Republic's vast communications network is so overworked as the Santos to Jundiai Railway (Estrada de Ferro Santos a Jundiai) which carries traffic from the Atlantic Ocean seaport, Santos, to Sao Paulo, Brazil's second largest industrial city.

In 1950, movement of freight along the railroad reached a peak of 48,000,000 bbl. Nineteen per cent, or 9,286,976 bbl, consisted of petroleum and its products, exceeding both coffee and cotton, two of Brazil's major products.

Of the total Brazilian oil imports, more than 28,000,000 bbl in 1949, some 48 per cent, passed through the port of Santos enroute to Sao Paulo and the hinterland.

Renato Azvedo, the young and capable engineer-president of the E. F. S. a J., was one of the first to recognize the difficult transportation problem and to initiate the idea of the pipe line. When the decision was made by the Conselho Nacional do Petroleo—the Brazilian government corporation charged with oil exploration as well as petroleum import controls—it was Azvedo who was given responsibility for Brazil's first pipe line.

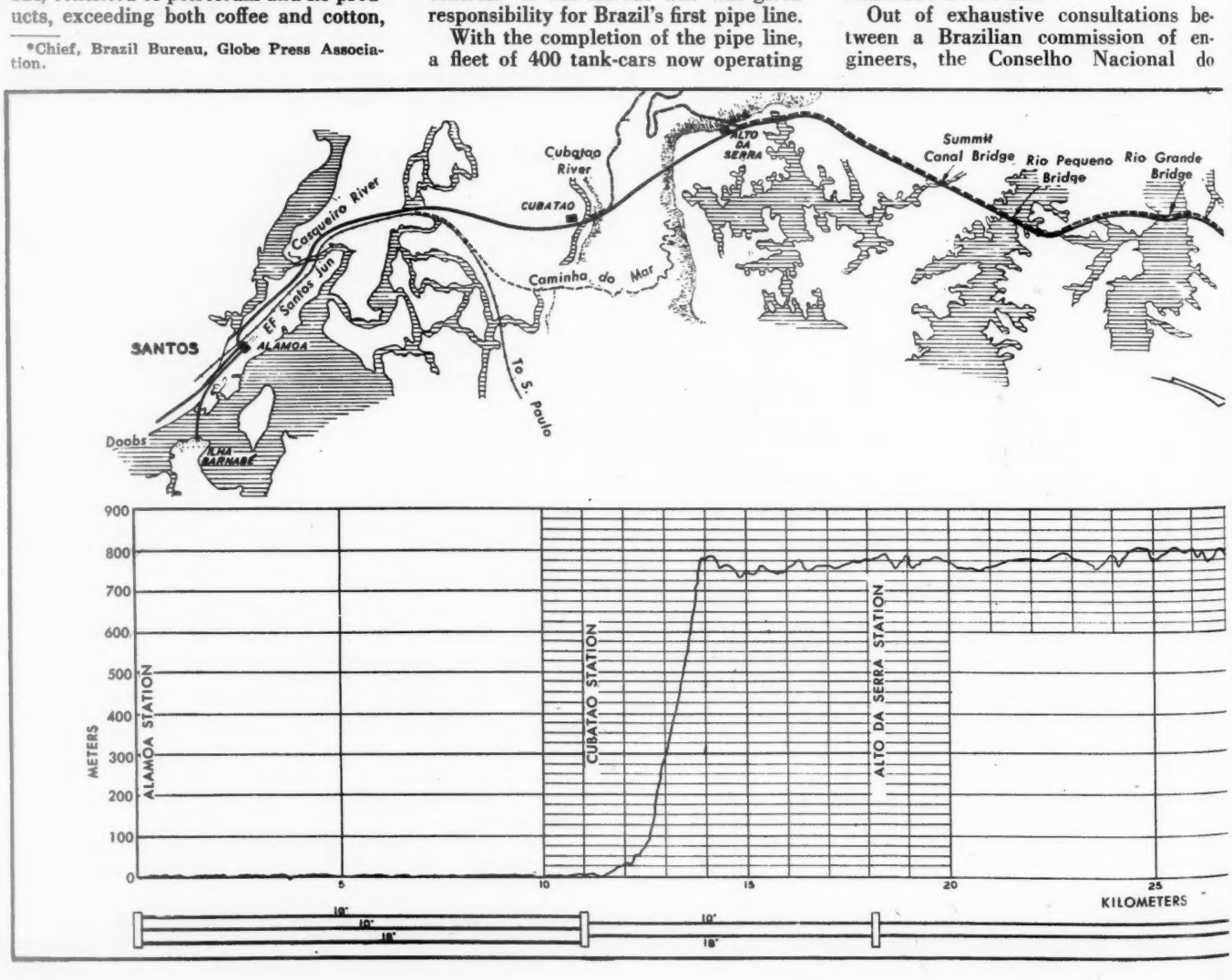
With the completion of the pipe line, a fleet of 400 tank-cars now operating from Santos to Sao Paulo, will be free for use elsewhere in the country.

Backers of the pipe line envisage not only pumping crude oil imports from Santos docks to markets in Sao Paulo, but also pumping crude oil to and refined petroleum products from the Cubatao refinery now being built near Santos.

One of the chief reasons for building the pipe line was to unburden the E. F. S. a J. Looking ahead, Azvedo and other officials hope to see the Santos-Sao Paulo line connect with other Brazilian railroads and one day serve as a link in a rail network reaching to South America's west coast.

Out of exhaustive consultations between a Brazilian commission of engineers, the Conselho Nacional do

*Chief, Brazil Bureau, Globe Press Association.



Petroleo, and William G. Heltzel, an internationally known North American pipe line consultant, the Heltzel Report of 1948 was produced.

This report examined the project from every aspect, cost, technical difficulties to be overcome, capacity, etc.

Not the least of these considerations was the extraordinary development of the city and state of Sao Paulo, and the calculation of future demands on the pipe line's capacity.

The daily consumption of the city was estimated at about 20,000 bbl, i.e., 3180 tons of gasoline, diesel oil, kerosine, solvents, heavy and light lubricating oils, and other fuel oils. Beyond this figure, the Heltzel report abandoned the idea of making an exact evaluation of Sao Paulo's requirements, but rather depended upon general principles.

In addition there were these factors: Brazil is badly depleted of fuels. Firewood is rapidly becoming impossible to obtain near the large cities. It is so scarce that its cost is now reckoned at three times an equivalent amount of fuel oil. Coal, found only in the southern part of the country, is of poor quality.

The hydroelectric plant at Cubatao, which supplies the city and a large part of the state of Sao Paulo, is nearing the limit of its capacity.

Another source of fuel, artificial gas made from coal, is expensive due to the long haul it must undergo to reach the fabricating plants.

Motor transport in Sao Paulo, and Rio de Janeiro, and Brazil's other large cities is increasing rapidly—especially with the growing construction of all-weather roads like the new highway from Rio to Sao Paulo. In the one year, 1945-46, gasoline consumption in Sao Paulo has increased 84 per cent and fuel oils 33 per cent.

The report pointed out that the permanence of a property depends not only on its physical life—which in the case of a pipe line can be predicted exactly—but also on its economic life.

Based upon 50 years' experience in the U. S. A., the Commisao Interestadual de Comercio set 20 years as a good "life expectancy" for the Santos-Sao Paulo pipe line. It pointed out also that the proper periodic renovation of the pipe line and the use of improved models in pumping equipment as they are devised, is more important in the life of a pipe line than the actual wear and tear on the line itself.

On the basis of this phase of the report, 70 per cent of the capital of the $18,000,000 pipe line enterprise has been invested in obtaining the latest model equipment, and pumping equipment has been made interchangeable so that it may be refitted at any time.

A large part of this pumping equipment has been supplied by Worthington do Brasil, S. A., of Rio de Janeiro.

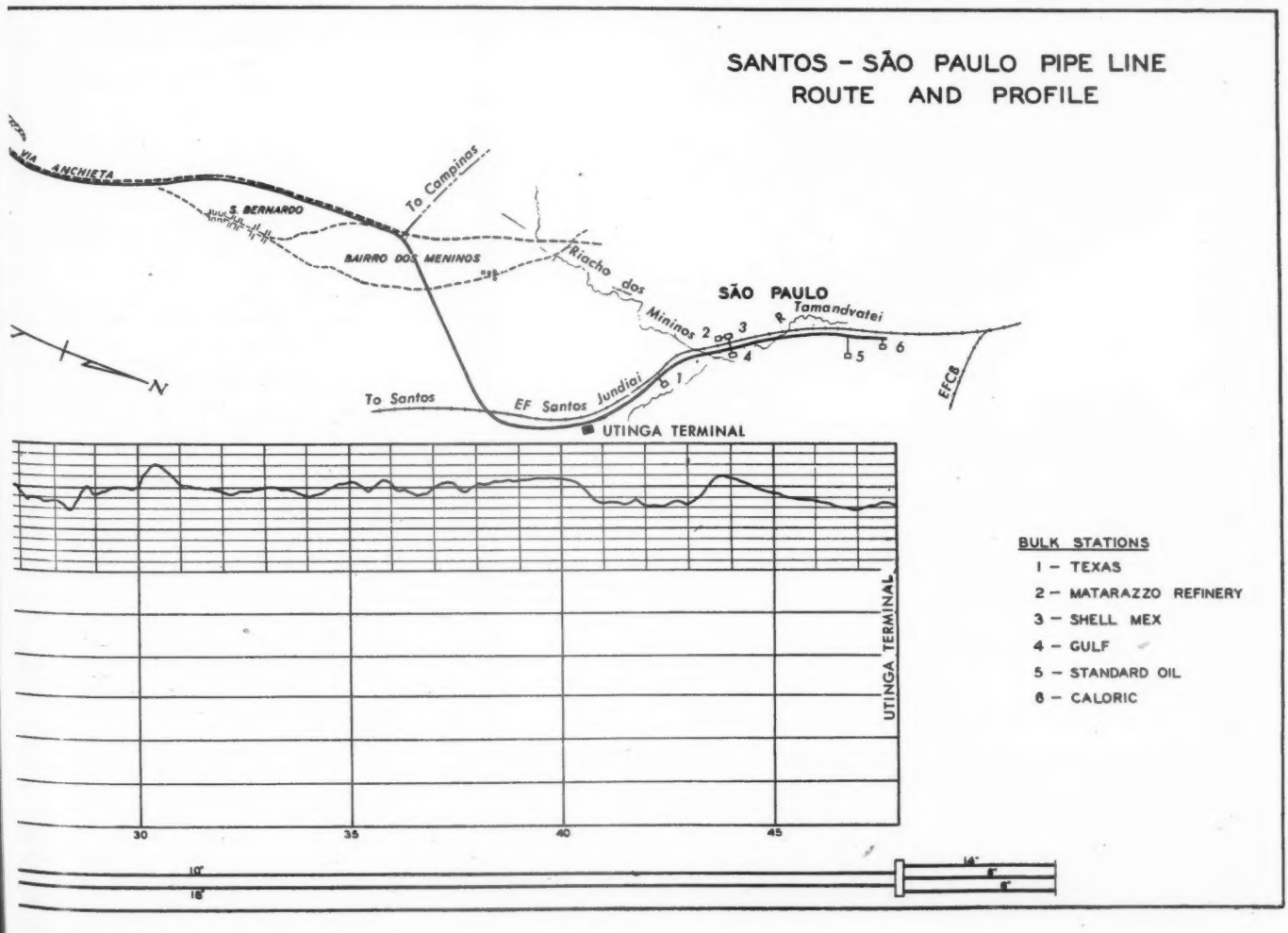
The terrain through which the pipe line runs between Santos and Sao Paulo is particularly difficult, including swamps, several lakes, a range of mountains, and urban areas. In addition, land prices are high; in some instances 10 to 12 times that of similar rights in the United States.

Heltzel's first step in making the technical decisions for the pipe line was to choose from several types the most efficient system. His report points out clearly that foresight as to possible expansions of a line had been the secret of success of several American lines.

One of the questions was whether 6, 10, 16, or 18-in. pipe for light oils should be used for the pipe line, and 12, 16, or 18-in. pipe for the heavier fuel oils. A decision also had to be made on whether a high or low pressure system would be used.

A particular problem for the Santos-Sao Paulo pipe line was the mountain ascent the line had to make from sea level at Santos to the high plateau on which Sao Paulo is situated. The lines had to mount 725 meters in four kilometers (or 2378.6 ft in a little less than 2½ miles), creating a pressure of 1020 psi at the bottom of the range for fuel oils, and 890 psi for lighter petroleum products.

Under normal circumstances a pumping station would have been constructed half way up the mountainside to reduce pressures and to do away with intermediate stations, but the severe slope of the mountainside, which has frequent avalanches caused by heavy seasonal rains, prohibited this construction. Because of this situation plus the pressure



for compensation for the friction—particularly of the heavier oils moving through the pipe—it was determined that pressure at the seaport end of the pipe line would have to be from a minimum of 900 psi to 1600 psi for light oils, and 1020 psi to 1500 psi for heavy oils to boost them to the relay station at 16 kilometers, depending on temperature and oil viscosity.

The second condition, which forced the adoption of a high pressure system, was the high viscosity of dark oil, which produces a severe loss of pressure by friction.

Heat losses in the system were evaluated with extreme accuracy according to formulas that have been worked out, but other circumstances such as the nature of the ground, its humidity, its temperature, could only be estimated.

Four Worthington pumps were installed at the initial pumping station at Cubatao (Santos). Two Worthington Triplex, horizontal, 4½-in. by 18-in., 81 rpm, 20,000 bbl per day, driven by 500-hp electric motors, will handle the light oil products. For fuel oils, two Worthington Triplex 4½-in. by 18-in, 61 rpm, 15,000 bbl per day, driven by 450-hp electric motors, will be used.

At the top of the mountain range is the Alto da Serra pumping station. Here the fuel oil pressure is boosted by two Worthington pumps used to pump the oil on into Sao Paulo. They are 450 hp and of the same specifications as those at Cubatao.

It is these six pumps that will do the major job of keeping the oil flowing from the docks where it is unloaded to the consumers in Sao Paulo and beyond.

Once having assumed the necessity for the high pressure system, Heltzel chose 10-in. pipe for light oils pointing out that it had 1.82 times capacity of the 8-in. pipe, even though friction losses were 2.94 greater with the 10-in. The 10-in. line can deliver 59,000 bbl of gasoline in 24 hr, a volume considered large enough to satisfy future demands on the pipe line.

The difference in cost between the 8-in. and the 10-in. pipe will be easily absorbed, the Heltzel report said. Rent by oil companies for increasing demands in Sao Paulo and emergency shipments that the 8-in. would have been unable to handle, will compensate for the greater construction cost of the 10-in., it is thought.

Much more difficult was the selection of the proper pipe for fuel oil. After considerable discussion, it became apparent that 18-in. pipe was best.

The Heltzel report recommended:

1. Two main oil pipe lines between Santos and Sao Paulo (Utinga) (28.7 miles). One 10-in. for light oils and one 18-in. for fuel oils.

2. Two high pressure pumping stations, one in Alemoa (a district of Santos) for all products, and another at 16 kilometers along the route of the pipe line for fuel oils only.

3. Two distribution lines between the terminal and the tank yard in Utinga and Mocoa (industrial suburbs of Sao Paulo), 4.6 miles away, one of these fitted with 6-in. pipe for light oil products and 10-in. pipe for the fuel oil.

4. One terminal in the Sao Paulo vicinity.

5. A small terminal for unloading railroad tank-cars and truck-tanks connected with the distributing lines.

An additional line is envisioned to Campinas, but not until consumption reaches 6000 bbl a day.

The line has been laid 1 meter (approximately 40 in.) below ground except up the slopes of the mountain. In this section, the pipe will rest on concrete blocks above ground.

Standard Oil Company do Brasil, Shell-Mex-Brasil Ltd., The Texas Company, South America Ltd., Companhia Brasileira do Petroleo Gulf, S. A., and Atlantic will use the pipe line jointly.

It will be possible to send different products through the line without endangering their purity, but for full success of this system, it has been found necessary to limit batches to a minimum of 20,000 bbl, or 2480 tons.

Williams Brothers Company of New York have acted as designing engineers and purchasing agents for the E. F. S. a J.'s Comissao do Oleoduto, a special committee of railway officials who are charged with construction and operation of the line. Heltzel is continuing to act as adviser on the project. * * *

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P 615.635.4

Operations and Maintenance of Pipe Line Cathodic Protection Systems

A system of monitoring by non-technical personnel is advocated, thus providing closer supervision than is otherwise possible

MARSHALL E. PARKER

MUCH of the effort, ingenuity, and expense that have gone into the design and installation of a system for the cathodic protection of a pipe line may be wasted if proper care is not taken to give the system the operation and maintenance it deserves. The fact that such a system—whether using purchased electrical energy or expendable galvanic anodes—is ostensibly self-operating merely means that it *may* continue to function without attention; it emphatically does not mean that it *will* do so.

The factors that make supervision of cathodic protection necessary fall into four general categories: (1) Deterioration, normal or extraordinary, of the protective devices or of the protected structure; (2) damage, to either system, which either increases the protection needed by the pipe or decreases the protection afforded by the system; (3) changes in the pipe line or its appurtenances, which either increase the current demand or interfere with its proper distribution, and (4) changes in other metallic structures within the influence of the system, which may interfere with the protection being afforded, or may involve foreign structures in the interference pattern of the current flow.

Deterioration

All materials and systems in use for pipe coatings are subject to some deterioration under the influences to which they are subjected underground. Stresses imposed by the alternate shrinking and swelling of soils with variations in moisture content tear at the coating and open cracks or extended cracks already existing. Roots penetrate and injure coatings. Uneven settling of the backfill, pressure by clods and stones, all are capable of increasing the exposed metal surface of the pipe.

Nor are pipe coating materials absolutely and permanently waterproof. Some penetration of moisture can be expected with even the best of coatings; the effect of this increased coating conductivity is an increase in the amount of current needed to maintain protective potentials.

The increased current demand brought about by any of the deterioration described will make itself known by a lowering of the pipe-to-soil potential. There may also be an increase in the amount of current flowing, depending upon the nature of the system. If a more or less constant voltage supply is used, either a rectifier or a set of galvanic anodes, there will be an increase in the current. Whether this occurs or not, however, there will always be a drop in the pipe-to-soil potential over those portions of the line where the coating is failing, and usually also over other sections.

The devices that supply the protective current are not themselves immune to deterioration. The rectifier stacks are subject to an aging process, in which there is a progressive increase in the forward resistance and often a decrease in the reverse resistance. This produces a lowering of current output and an increase in the amount of lost energy, which appears as heat. Increased heat losses lead to a rise in temperature, which is in itself conducive to inefficiency or to outright failure.

The Author

Marshall E. Parker is a consulting engineer located in Houston, Texas. His activities are chiefly concerned with the mitigation of corrosion on metallic structures, and the major portion of his practice has been in the petroleum industry and with public utilities and municipalities. He was formerly associated with Cathodic Protection Service, and prior to that with Pan American Pipe Line Company. He holds a BS degree from Sam Houston College and a BA from Rice Institute, and is a registered professional engineer in Texas. He is the author of numerous articles on the subject of corrosion, many of which have appeared in *The Petroleum Engineer*.

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Air-cooled units are subject to progressive clogging of the screens by dust, as well as by the nest-building activities of birds and insects. Higher temperatures and lower efficiencies are the result.

Ground beds (in systems using impressed current) are subject to polarization, which increases the resistance of the circuit. They are also subject to the consumption of the anode material, which also increases the resistance. This increase may come about gradually, or it may come in sudden spurts, particularly when long sections of junk pipe are used as anodes, when a concentration of current discharge at one location severs the pipe completely.

All these changes, which decrease the output of the rectifier or which increase the resistance of the anode bed, make themselves known by a decrease in the current flow and a decrease in the value of the pipe-to-soil potential. The change in current, it will be noted, is in a direction opposite to that caused by coating deterioration, but the potental change is as before.

Galvanic anodes likewise are subject to polarization and to increase of ground resistance by drying out and by the shrinkage of the backfill out of contact with the surrounding earth. In either case the effect produced is that of lowered current output and of lowered pipe-to-soil potential.

It should be noted that polarization of the anode, whether in an impressed current or a galvanic anode system, is undesirable in that it reduces the amount of protection afforded. Although polarization of the pipe is to be desired, its effect is that of increasing the pipe's resistance to ground, so that the current flow decreases whereas the pipe-to-soil potential increases. The hydrogen film formed on a protected pipe will persist for several hours, sometimes days, and maintain protection even with the cathodic protection devices completely disconnected.

Damage

There is no end to the number and kinds of damages that may occur to the components of a cathodic protection

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system. Buried wires may be cut by plows, or by earth-moving machinery; insulation may be damaged, and, if on the anode lead, the conductor eaten away by electrolytic action. Rectifiers and their supply transformers may burn out; power supplies may fail. The effect of any of these events naturally will be the loss of whatever portion of the current the damaged unit was supplying; this will involve a decrease in the pipe-to-soil potential.

The coating on the pipe itself is vulnerable to damage also. In the open country, such damage is not too common, and is usually limited to locations where construction operations cross the pipe. In cities, the repair or construction of other underground utilities is often accompanied by severe local coating damage. As the amount of damage that can be done at a single crossing cannot involve a very large percentage of the total area of a pipe line, the effect upon the current demand is not likely to be very large, but there may be serious loss of protection in a small area. In general, the better the coating on the line, the more marked will be the effect of local damage on the performance of the cathodic protection system.

Another type of damage that is capable of producing a very large change in current demand is that which occurs when, due to settlement of the soil or movement of the pipe, the coating is cut through and the pipe short-circuited to a bare casing. In this case, the loss of a couple of square inches or so of casing can result in the addition to the protected system of several hundred square feet of bare metal. As this may easily exceed several miles of line in current demand, the effect upon the protection is disastrous.

Similar damage may occur to insulating material in flanged joints, the short-circuit of which connects the protected line to a system whose protection for one reason or another is not intended. This may vary all the way from a slight additional unintentional load to one that is hopelessly impossible.

The damage done by the construction of a crossing line is not always limited to the knocking off of a few square feet of coating. The crossing line may be so laid that it is directly in contact with the one under consideration, which will impose upon the system a considerable additional load. The short-circuit does not always take place at or immediately after the time of laying. Pipe movement may bring together two lines that originally were separated, or may rub through a coating originally insulating. The possibility also exists of the line's being short-circuited to other extensive grounded metallic structures, such as bridges, tower footings, and other like structures.

These accidental short-circuits and cross-connections produce effects similar to those of declining coating quality, except for the greater suddenness of their appearance. The current demand will increase, and the pipe-to-soil potential will decline.

Changes

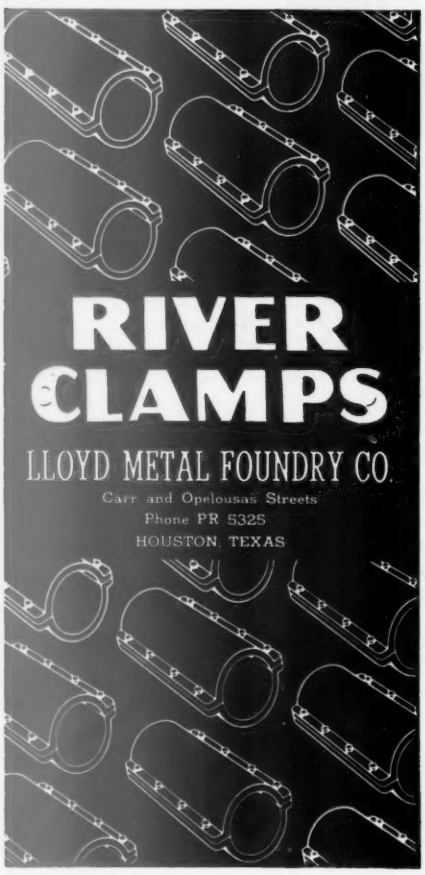
Unfortunately, the organization of many pipe line companies is such that different departments are not always advised regarding each others' activities. Often changes and revisions in the piping arrangements at stations and manifolds will be made that bypass the carefully designed insulated joints whose purpose is to separate protected sections of the pipe from other metallic structures such as tank farms, bare piping, gathering systems, and foreign lines. A single half-inch gage line can effectively nullify the insulation in a large diameter trunk line and may deprive many miles of protection. A case is known in which a quarter-inch piece of copper tubing connected 12 miles of 16-in. pipe to the vast mass of bare piping at a gasoline plant, and made the efforts of a cathodic protection system completely without effect.

Instead of bypassing insulation, the changes may consist merely of additions to the system, which overtax its ability to protect. Gathering systems particularly are likely to meet with this kind of treatment. The additions, which increase the load on the systems, are not necessarily in the form of piping, nor are the connections always through piping; instances are known where walkways, guy-wires, and other metallic components afford the undesired path to ground. Such connections are very likely to be overlooked by personnel not fully conversant with and accustomed to the requirements of cathodic protection.

Examination of the preceding categories of difficulties that may befall a cathodic protection system will disclose that there is one effect common to all types of failure—the pipe-to-soil potential decreases. This must of necessity be the case, so long as this is the function in terms of which protection is actually defined. However trivial the observation may be, it does indicate the simplest and most effective means of maintaining supervision over the operation of the system. So long as the pipe-to-soil potential is at a satisfactory level, the system is performing adequately. When it drops below the desired value, something is amiss. Further investigation may be required to determine the nature and location of the failure, but the fact of its existence is clearly established.

This does not mean, of course, that no attention should be paid to other features of the system. Ammeters and voltmeters on the rectifiers should be read and recorded systematically; failure to attend to this may result in an overloaded unit with subsequent failure. Screens on air-cooled units should be kept clean, and the general principles of good housekeeping by all means should be observed.

The current output of galvanic anodes should be checked at intervals, in order that their exhaustion may be anticipated in time for replacement. In order to facilitate this operation, simple low-resistance shunts should be installed in the lead wire of each anode group. In the



case of a line protected by anodes singly, rather than in groups, a representative sampling of typical anodes should be equipped with shunts. Low resistance is necessary in the shunts, or they may limit the current output of the anodes below the desired values. Satisfactory shunts with a value of 0.01 ohm are commercially available.

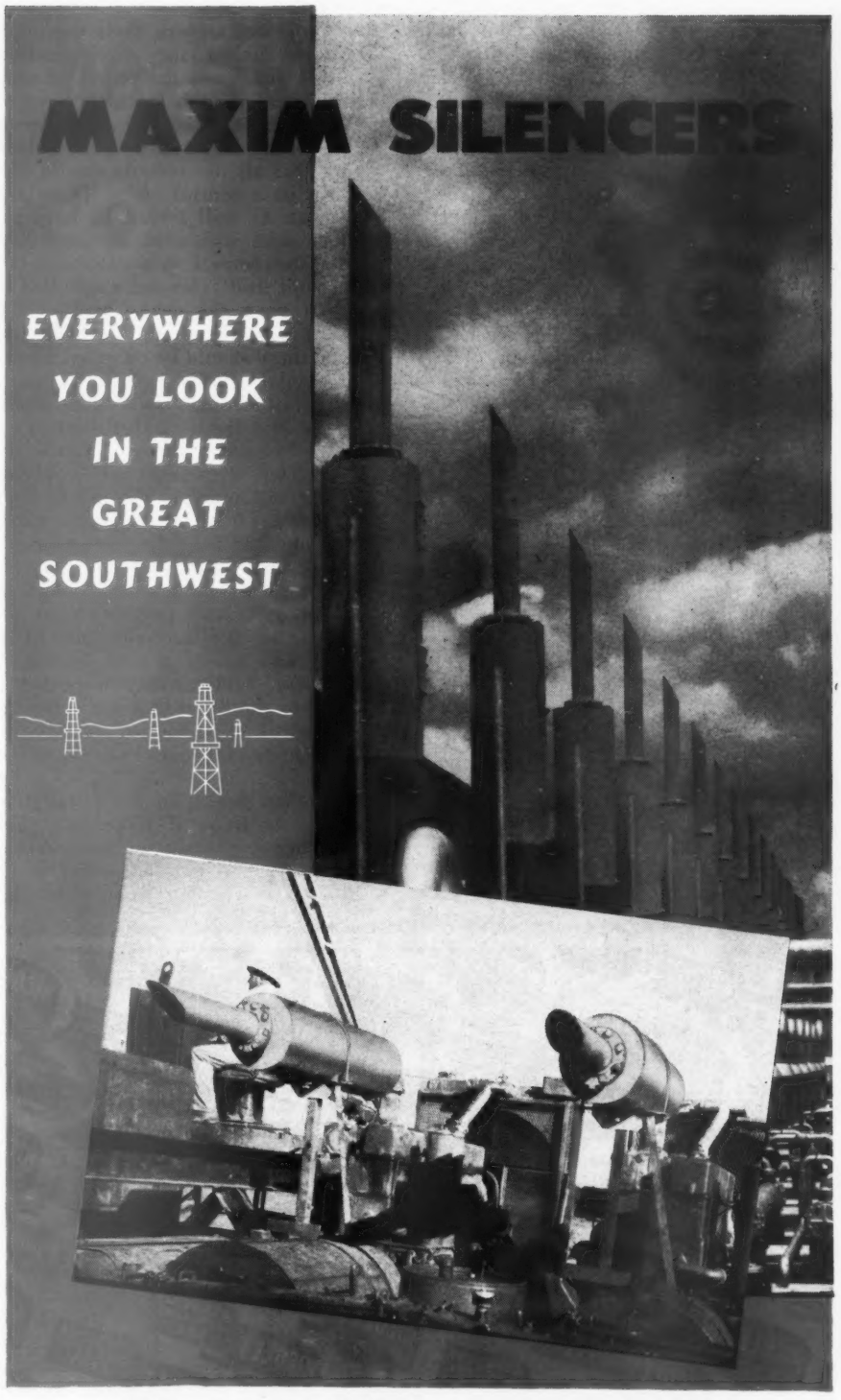
The periodic inspections of the system, then, serve two functions; first, to detect any remediable damage or deterioration that might ultimately reduce the effectiveness of the protection or increase its cost; and second, to detect as soon as possible any actual failure, partial or complete, of the system to provide the protection for which it was designed. These two different functions can best be served by two different kinds of inspections; the first, scheduled and systematic inspections of every accessible device in the system at intervals depending upon (1) the importance of the component and the seriousness of the consequences that would follow its failure, and (2) the relative ease with which the inspection can be made; the second, by the simplest possible kind of a check made at frequent intervals.

The scheduled and systematic inspections differ markedly with different systems, and can best be discussed by considering three basic types of cathodic protection systems: (1) A rectifier-ground bed system; (2) an installation of galvanic anodes in groups, and (3) an installation of individual anodes, such as might be used for the "hot spot" protection of a bare line.

Rectifier-Ground Bed System

The two meters with which most rectifiers are equipped should be read at least once a month. Where the location is such that no travel is required, as when the unit is at a pump station, daily readings are not too often. Other units may be situated where weekly readings will involve no great expense or inconvenience. So long as these two values remain reasonably constant, there is assurance that the system as a whole is functioning more or less normally. Some seasonal variation is to be expected because resistance of the anode bed will vary with the amount of moisture in the ground, as will the resistance of the pipe itself. Coating deterioration, as already described, will lower the pipe resistance; this will result in an increase in the current. The voltage may or may not change appreciably.

Sudden changes either in current or voltage indicate sudden changes in the circuit, and should be investigated immediately. If the current output rises above the rating of the unit, the voltage should be reduced until the load can be safely carried, if, indeed, the circuit breaker has not already operated, or if the unit is not already damaged. Then the cause of the sudden increase in current demand should be sought. It will almost invariably be found to have resulted from the connection to the pipe under protection of a large mass of metal initially separate from the sys-



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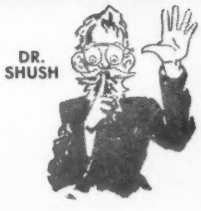

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tem. Perhaps an insulated joint has been bypassed or shorted, or perhaps a casing has shorted out to the line.

If the situation can be remedied, the voltage setting of the rectifier may be increased to its former value when the short has been cleared. If it is found to be a shorted casing, it may become necessary to provide larger current capacity in order to maintain protection on the pipe. This may be done either by the substitution of a larger rectifier (with enlargement of the ground bed), by the installation of an additional unit, or by the installation of supplementary magnesium anodes in the vicinity of the shorted casing.

A sudden drop in the current output of a rectifier, which may be accompanied by a rise in the voltage, is usually indicative of trouble in the ground bed. One or more anodes may be consumed, or one of the connecting cables may have become disconnected. An exploration of the surface potentials over the area of the ground bed will show which anodes are still in operation without the need for any excavation. If the current has dropped to zero, the unit may be out of operation, due to any one of a number of possible failures; but if the terminal voltage is still present and the current is zero, then either the anode bed or the pipe is completely disconnected. In this case, some excavation may be needed for spot potential checks until the discontinuity is isolated.

The routine readings recommended above will not achieve their maximum usefulness unless they are carefully recorded and made the object of some study. It is quite helpful to have on hand, at or near the unit, a complete record of its history; it goes without saying that all the records should also be kept in a central office. These two needs can be well served by having a small booklet, with alternate pages perforated for removal, in a watertight box at the unit itself (for units installed at pump stations, the record book should be kept with the pump log). In this booklet there should be recorded all the pertinent data, including information regarding tap settings, connections, serial numbers, and the like. Most commonly, only the two meters (in addition to the power meter, if there is one supplying the unit) will be read—this can be done by almost any company employee whose duties take him near the rectifier. Such readings should be dated and initialed for identification. When a page is filled, or at shorter intervals upon instruction, the duplicate copy should be removed and mailed in to the corrosion department. A notice may be posted at the unit to the effect that the corrosion department is to be notified immediately if the readings fall outside the specified range.

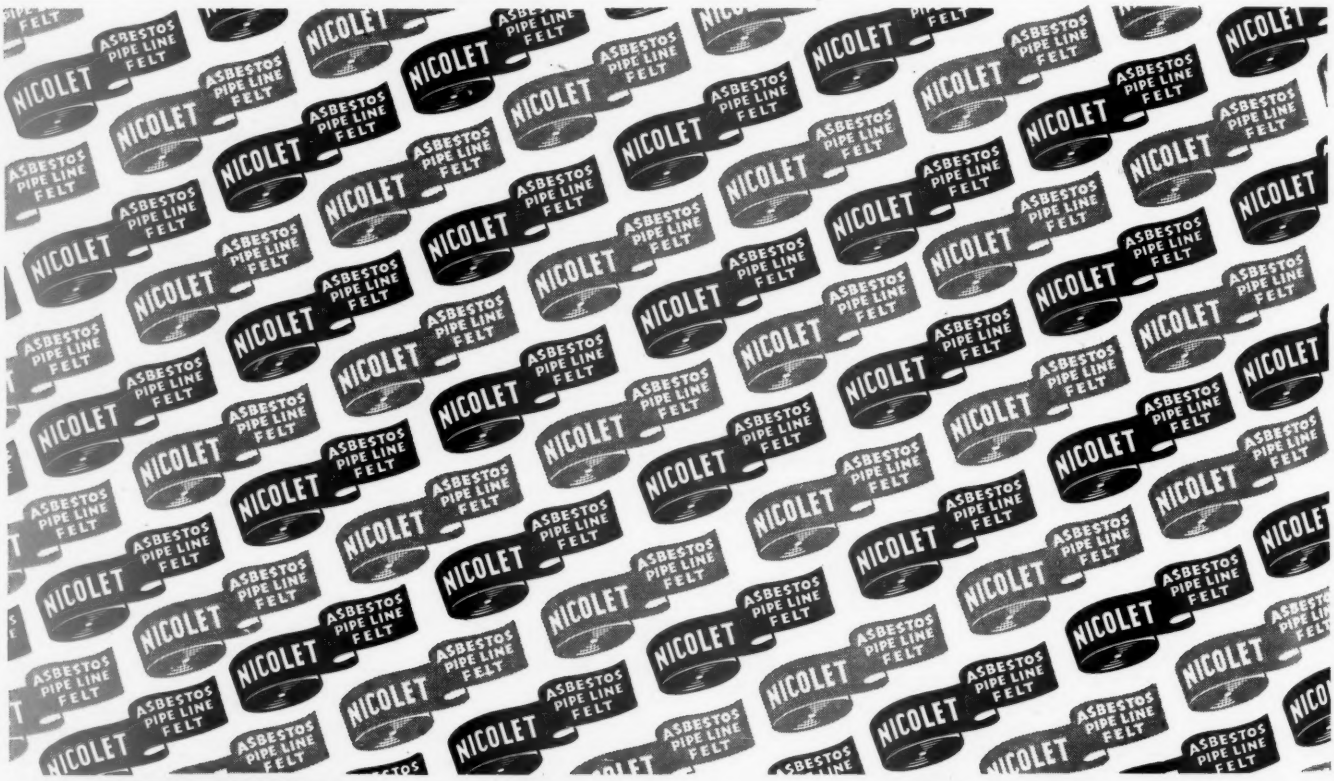
The other aspects of the installation require less frequent inspection. The ground bed itself calls for none, except for a general visual inspection if its location is subject to erosion or similar damage. It is suggested that a complete inspection of the unit be made once a year, at which time the screens should be cleaned, the oil checked (if an oil-cooled unit), needed painting should be done, and any other features that may seem necessary attended to.

In the analysis of the recorded current and voltage readings, trends may be discovered and recognized more readily if the values are plotted on curves, as a function of time. It is helpful to use a standard sheet for all units, with a time scale covering 5 or 10 years. The vertical scale may be modified to take care of variations in the size of the units. Some interesting comparisons may be made if rainfall data are plotted on the same sheets. The slow deterioration of coating, the variation of resistance with soil moisture, the sudden effects of construction damage, all show up on well-kept records of this kind.

Galvanic Anodes in Groups

Coated lines often can be placed under cathodic protection by the installation of galvanic anodes—usually magnesium—in groups. The electrical behavior of such a system does not differ in principle from that of one using rectifiers, except that the individual drainage points are smaller and more closely spaced. Consequently, the general supervision needed is much the same, except for differences inherent in the two sources of energy.

There are few data to be taken at a



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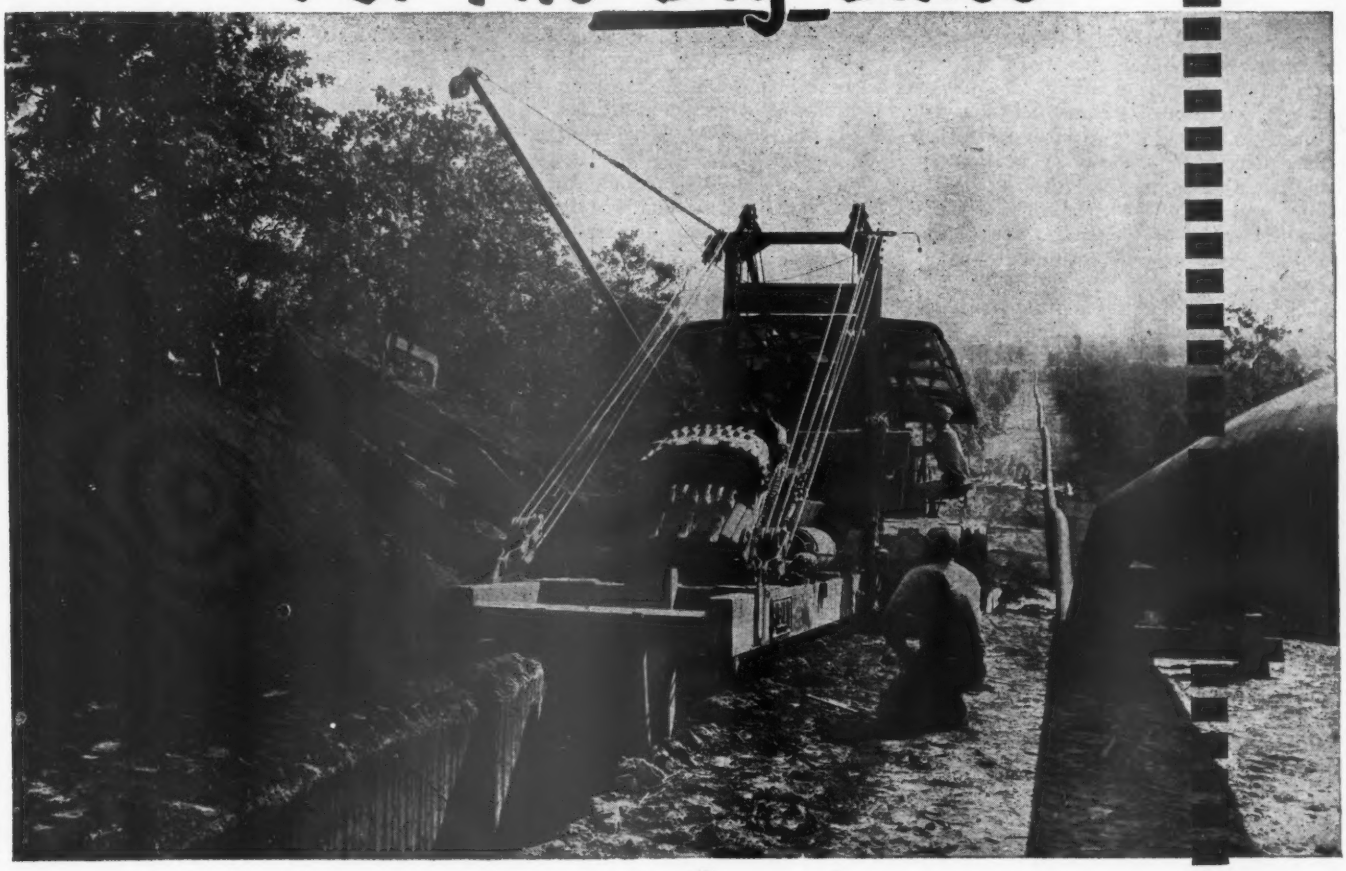

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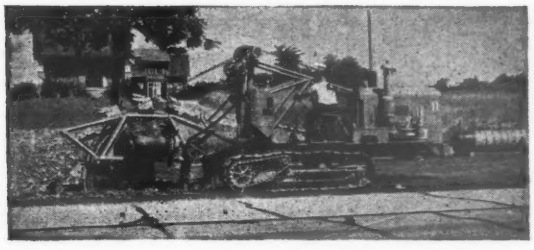

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group of anodes besides the total current output of the group. Because of the larger number of locations and the usual relative inaccessibility of some of them, it is not recommended that readings be taken as often as in the case of rectifiers. Three sets of current readings a year generally will suffice, although it will be helpful if monthly readings are taken on a selected set of stations not too difficult of access. On any extensive installation, there will probably be a few stations that are in extremely difficult locations, and a few that had to be buried completely without lead wires or shunts; these may be omitted from the scheduled surveys.

The data should be plotted on time sheets, just as the data from the rectifiers previously described. The few stations selected for monthly readings will then establish the general shape of the curves, and, if their locations are reasonably typical, not too much risk is involved in assuming that the other stations are behaving similarly.

Single Galvanic Anodes

When single galvanic anodes are installed, usually some form of "hot spot" protection is being sought, and usually the line involved is bare. The large number of points to be checked, the common variability in the current output and hence the projected lives of the anodes, and the admittedly partial nature of the protection all combine to make complete supervision difficult and expensive. In addition to these considerations, there is usually the assumption that such an installation represents an incomplete program rather than a system of full protection—additions may be made at any time, as the need is indicated.

Some few of the individual anodes may be installed with lead wires brought out so that current output may be read from time to time, and from these values an idea can be had of how the installation as a whole is faring. As a general rule, however, such a system receives less attention than either of those already described.

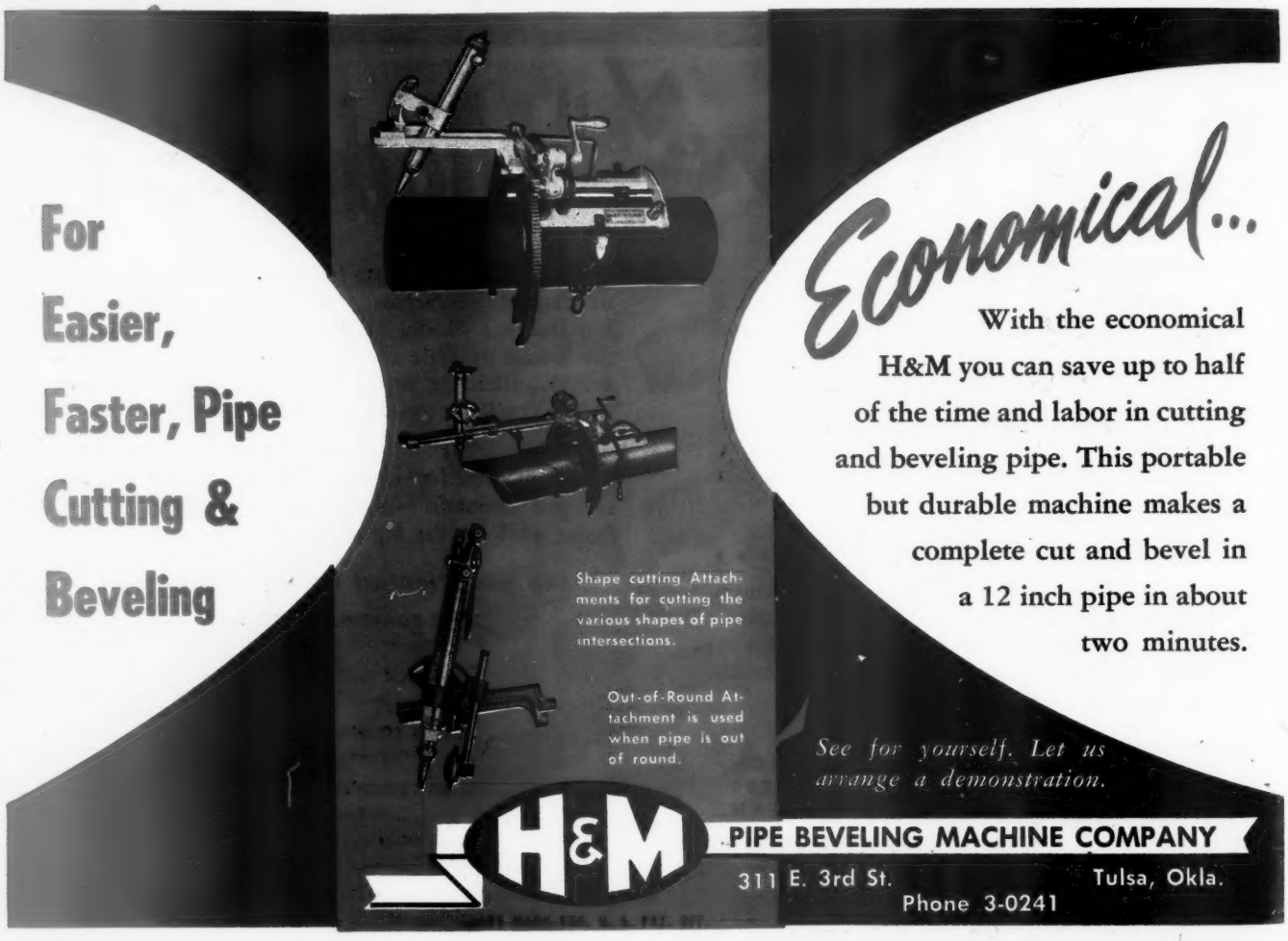
Pipe-to-Soil Potential

In the description of quantities to be observed for the supervision of rectifier-ground bed and of galvanic anode group systems, no mention has been made of measurements on the pipe line at points other than the drain points. The measurements taken at the units themselves are primarily for the purpose of checking on the operation of these units; they do not in themselves answer the primary question of whether the line is receiving adequate protection.

Protection is usually defined in terms of pipe-to-soil potential. A common criterion is the maintenance of at least 0.85-volt negative potential, with reference to a copper/copper sulfate electrode, at all points of the line. It is not necessary to check all points of a line in order to determine the adequacy of protection. This quantity will have its highest values at or near the drain points, where the current is discharged to earth through the anode system. Between these points the curve of potential will sag; if the soil resistivity and the coating conductivity were both uniform, the shape of the curve—except for distortion in the immediate vicinity of anodes—would be that of a catenary, or suspended flexible chain. Variations in the soil, in the pipe itself, and in the presence of adjacent metallic structures, all cause distortions of this curve. There will be, however, a certain point or area between each pair of drain points where the potential is a minimum. Any failure of protection at any point in the section will inevitably involve a failure in protection at that minimum point.

It is possible, therefore, to monitor the operation of an entire section by monitoring the pipe-to-soil potential at one of these low points. Furthermore, a disturbance of any magnitude in either of the adjacent sections also will be detected. Failure at a low point does not disclose much information on the nature or location of the actual trouble, but it does make its existence known.

It is not necessary that the monitoring be done precisely at the point of minimum potential; a point more convenient of access may be chosen with little loss of validity. Test leads may be installed at road crossings on most pipe lines,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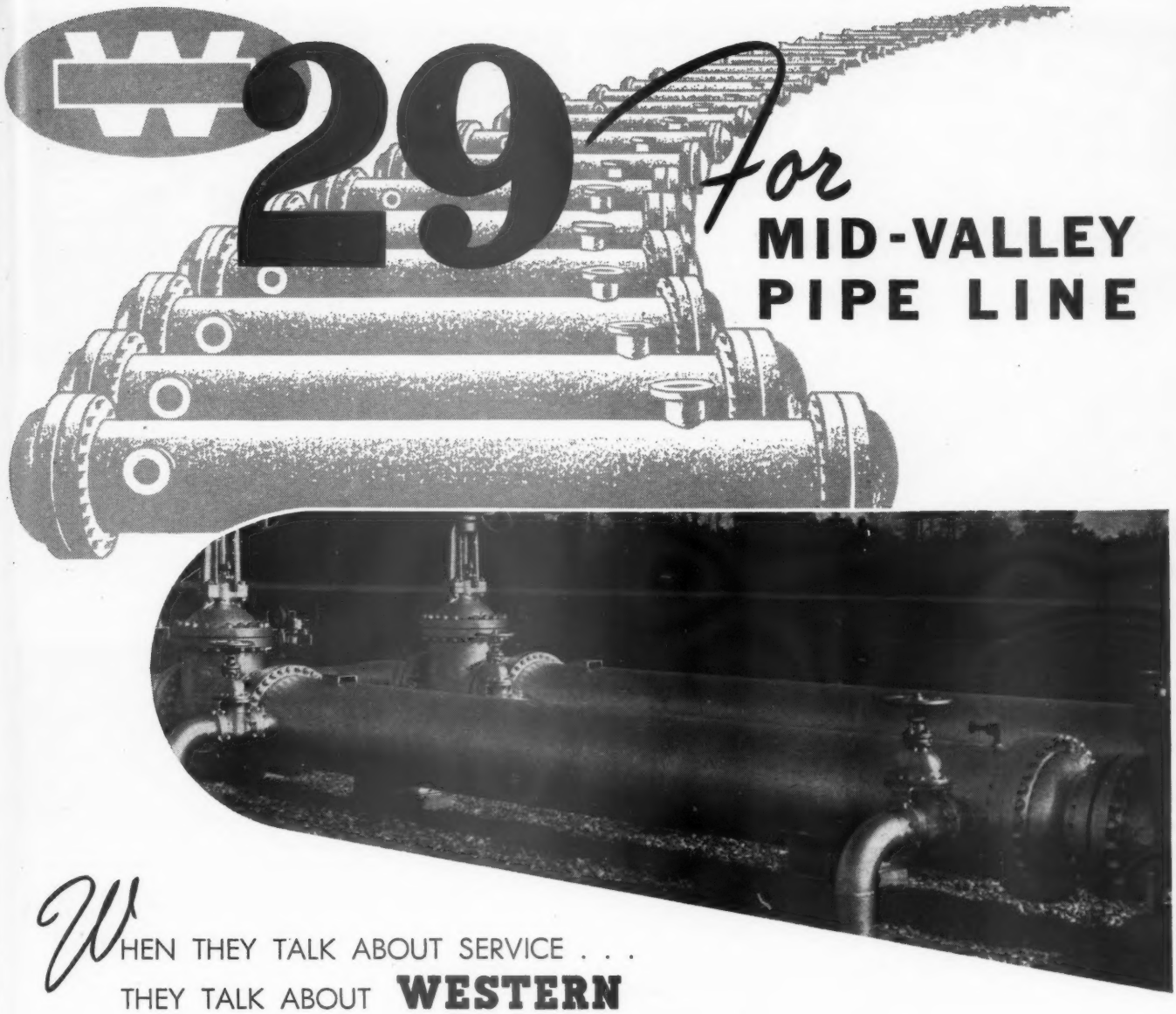

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without being too far distant from the optimum location. If the correct point is too inaccessible, then two points may be used on either side of it. Obviously, in such an arrangement, the potential must be higher than 0.85 at the check points in order to insure protection throughout.

For a line protected by rectifiers, it is recommended that a check point be established in each section included between two units. For a line using galvanic anode groups, at least one-third of the sections should have check points. Potential readings should be taken at each of these points as often as possible. It is recognized that daily, or even weekly, readings in most cases would involve unduly high costs, but if such intervals can be maintained, there will result a corresponding increase in the effectiveness of the protection.

Especially at pumping stations, or other locations where personnel is present regularly, readings should be taken with considerable frequency. Even when the location of a station is far removed from the optimum point, daily readings will be of value. It is not necessary that these readings be made with high precision, it is not even necessary that the potentials indicated are the true pipe-to-soil potentials. Ordinary voltmeters, with resistance far too low for usual corrosion test work, will serve quite well, particularly if the electrode used is of a low and constant resistance. A few comparisons with a potentiometer will enable the corrosion engineer to determine the readings, on the voltmeter, which will be indicative of lowered or lost protection.

Thus a routine can be set up whereby semi-skilled field personnel can maintain enough supervision over the operation of a cathodic protection system to detect any sign of trouble. The corrosion engineer, notified upon the observation of certain values, can make the complete investigation that will be needed to track down and remedy the failure, or he can make the necessary additions to or adjustments of the apparatus to take care of the increased current demands of deteriorating coating. The time in between his annual surveys can thus be devoted to other problems, perhaps at remote locations, with the confident assurance that the system is doing properly the job for which is was designed and installed. * * *

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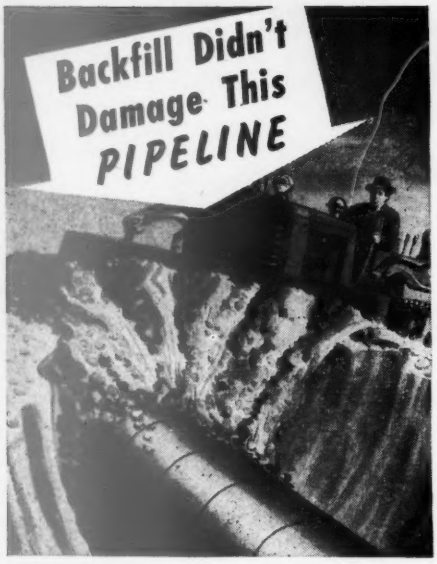

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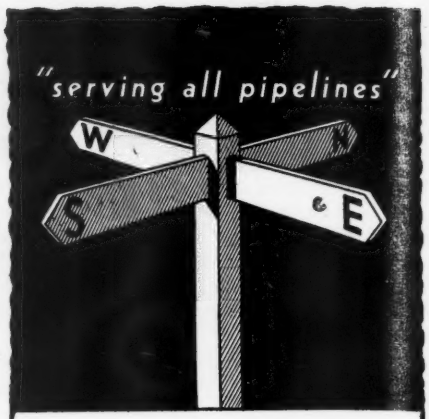

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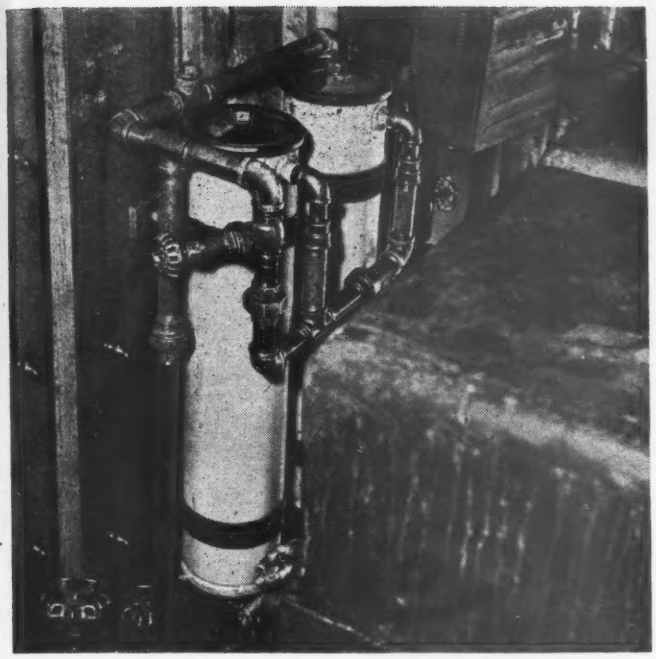

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1. Charles E. Bennett, president American Gas Association, addresses SGA members.
2. I. W. Dods, Transcontinental Gas Pipe Line Corporation; Oliver W. Fowler, Pan American Gas Company, and C. L. Pringle, Motorola, Inc. (SGA)
3. Sid Mourning and Don Klein, Standard Electric Manufacturing Company. (SGA)
4. Starr Thayer, consulting engineer, and E. N. Armstrong, Transcontinental. (SGA)
5. Dudley L. Rankin, Wyco Pipe Line Company, R. H. Lynch and Allen Baxter, Keystone Pipe Line Company. (API)
6. James E. Ford, V. C. Fairless, and J. M. Pearson, of Sun Pipe Line. (API)
7. J. D. Jones, A. H. Kemp, Jr., Carroll E. Suggs, and Arnold W. G. Muller, Gulf Refining Company, Tulsa pipe line division. (API)
8. L. F. Scherer, Texas Pipe Line, and Roy J. Tibbets, Sinclair Pipe Line. (API)
9. E. W. Lawlor, Pittsburgh Coke and Chemical Company; C. E. Dickey, Sinclair Pipe Line Company, and O. E. McCullough, Jr., Pittsburgh Coke. (API)
10. C. C. Keane, Great Lakes Pipe Line, and W. K. Borland, Plantation Pipe Line. (API)
11. SGA Panel Members: Thomas S. Bacon, Lone Star Gas; E. F. Hindman, Louisiana Natural Gas; T. S. Whitis, West Texas Gas; Earl Kightlinger, Albama-Tennessee Natural Gas, moderator; C. L. Perkins, El Paso Natural Gas, presiding.
12. G. W. Dreyer, Crutcher-Rolfs-Cummings; Don R. Ford, Magnolia Pipe Line, and Jerry Johnson, Sinclair Pipe Line. (API)

13. J. O. Dillon, W. R. Flanagan, Charles Fitzgerald, all of Sinclair Pipe Line, and J. C. Britton, Britton Contracting Company. (API)
14. Gerry Swinehart, Carl Byoir and Associates, speaking. L. L. Dyer, Lone Star Gas, retiring SGA president, seated.
15. O. A. Abbey, Standard (Ind.), Ralph Dougherty, Wyco, and C. F. Gearhart, Standard. (API)
16. E. T. Robinson, Jr., Texas Eastern Transmission Corporation; A. L. Gooch and J. R. Rutherford, United Gas. (SGA)
17. Jack Webber, Kaiser Steel Corporation, and H. E. Burtner, Midwestern Engine and Equipment Company. (API)
18. Humble Pipe Line Company men: P. D. Phillips, L. S. Wrightsman, O. Q. Lomax, and Dave McFadden. (API)
19. Robert R. Suttle, managing director SGA.
20. D. Y. Baldwin and Frank Stivers of Humble Pipe Line Company, and Olen W. Holloway, Sinclair Pipe Line. (API)
21. API speakers and officials: R. P. Dougherty, Wyco Pipe Line; J. H. McKenzie, General Petroleum; L. M. Miller, Sun Pipe Line; John W. deGroot, Tuscarora Oil Company; J. R. Giese, Great Lakes; George Brigance, Socony-Vacuum.
22. API Panel members: Seated, L. R. Dickinson, Socony-Vacuum; J. P. West, Sohio Pipe Line; G. D. Harden, Shell Oil; Ivy M. Parker, Plantation Pipe Line. Standing, W. G. Hortsman, Plantation Pipe Line, moderator; John W. deGroot, Tuscarora Oil; Dave Levy, Magnolia Pipe Line; L. M. Miller, Sun Pipe Line; L. E. Cook, Sinclair Pipe Line; John W. Furtral, Southeastern Pipe Line; Hugh E. Dischinger, Shell Oil, committee chairman.
23. Don B. Good and R. F. Dorsch, Texas Pipe Line Company. (API)

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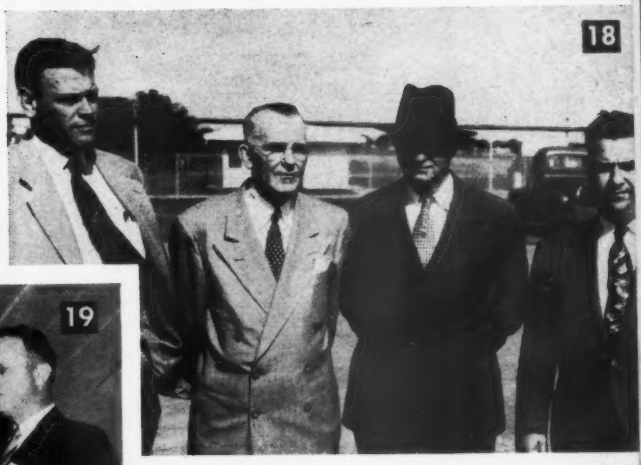
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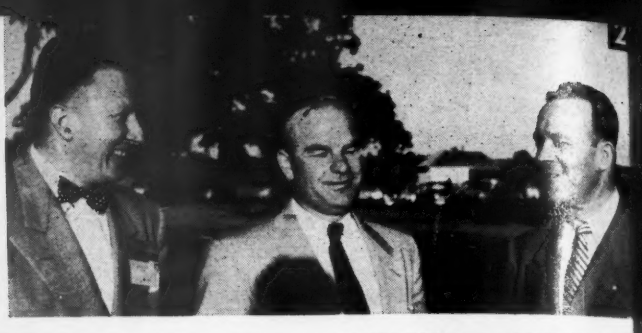

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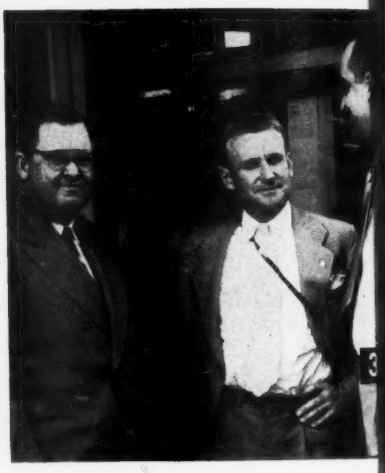

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24. API speakers and officials: John E. Boice, PAD; O. M. Turner, Standard Oil (Ohio); S. S. Smith, Shell Oil; George Brigance, Socony-Vacuum, session chairman; S. A. Hallberg, Standard Oil (Indiana); John W. deGroot, Tuscarora Oil, meeting chairman.
25. Earl Unruh, Sinclair Pipe Line; J. F. Johnson, Shell Oil, and Hugh Dischinger, Shell Oil. (API)
26. William H. Morris, Sinclair Pipe Line, and John G. Norton, Magnolia Pipe Line. (API)
27. R. E. Nelson, Jr., Standard Oil (Indiana); Herb Fisher, C-R-C Engineering Company; Sam Jackson, Standard Oil Company (Ind.), and E. J. Liggett, Johns-Manville. (API)
28. D. H. Lewis, C. E. Dolhonde, and F. V. Maloney, Shell Pipe Line. (API)
29. L. B. Moon, Sinclair Pipe Line, and L. H. True, Magnolia Pipe Line. (API)
30. C. W. Tomford, Buckeye Pipe Line Company, and E. J. Wacker, Magnolia Pipe Line. (API)
31. Bennie Means, Pittsburgh Coke and Chemical; Dean Glass, Pure Oil, and O. E. McCullough, Jr., Pittsburgh Coke and Chemical. (API)
32. E. H. Fortmann, National Transit Company, and D. P. Dugan, Tuscarora Oil. (API)
33. G. A. Lee and A. E. Payne, Humble Pipe Line, and "Osy" Osborn, Crutcher-Rolfs-Cummings. (API)
34. John L. Shaunty, Specialty Sales and Service Company, and M. J. Dabney, Plantation Pipe Line. (API)
35. New SGA officers: Front row, J. L. Campbell, New Orleans Public Service, secretary; H. V. McConkey, Southern Union, treasurer; J. C. Flanagan, United Gas, vice chairman, Advisory Council; John H. Wimberly, Houston Natural Gas, president; H. K. Griffin, Mississippi Gas, first vice president. Back row, E. R. Cunningham, Texas Eastern, director; Willard G. Wiegel, Lone Star Gas, director; W. D. Mastin, Robertshaw Fulton Controls, director; Kyle H. Turner, Atlanta Gas Light, assistant secretary. Not in picture: C. I. Wall, West Texas Gas Company, second vice president; D. A. Crawford, Atlanta Gas Light, and Hansell Hillyer, South Atlantic Gas, directors.
36. Earl Humble and Murrell Carlisle, Texas Eastern Transmission Corporation. (SGA)

Texas Eastern Operating Part of New Pipe Line

Texas Eastern Transmission Corporation has begun initial operations of its new 30-in. pipe line as far north as the Ohio River, according to an announcement by R. H. Hargrove, president.

Construction and testing of that section of the new line which extends from Kosciusko, Mississippi, to the Kentucky-Ohio crossing of the Ohio River has been completed and Texas Eastern now is delivering gas to the Appalachian area through connections with the Columbia Gas System.

The remainder of the line, Hargrove stated, will be completed this summer and when regular operations begin, plans provide for Texas Eastern to build up deliveries gradually to about 400 million cubic feet of gas per day through the new 30-inch line.

Pair of Pipe Line Profitmakers!

Here are two UNIT TRENCHOES speeding up the ditching operation on a cross country pipe line project. This type of operation is familiar to pipeline contractors because they know, when the going gets tough, it takes a rugged machine to do the job efficiently. UNIT TRENCHOE is this type of machine. Its fast operating speed is a real time and money saver on pipe line work. UNIT'S exclusive mechanical features, together with the streamlined FULL VISION CAB, make UNIT a front line machine in the pipe line construction field.

Then there are Mobile UNITS for jobs along the right-of-way. Mobile equipment offers road travel speed, plus sufficient traction to operate in rugged pipe line terrain.

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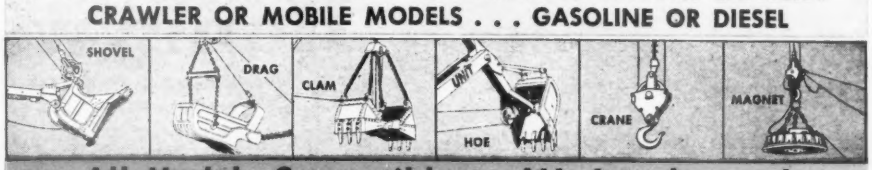
6603 WEST BURNHAM STREET • MILWAUKEE 14, WISCONSIN, U. S. A.

½ or ¾ YARD EXCAVATORS...CRANES UP TO 20 TONS CAPACITY
CRAWLER OR MOBILE MODELS . . . GASOLINE OR DIESEL

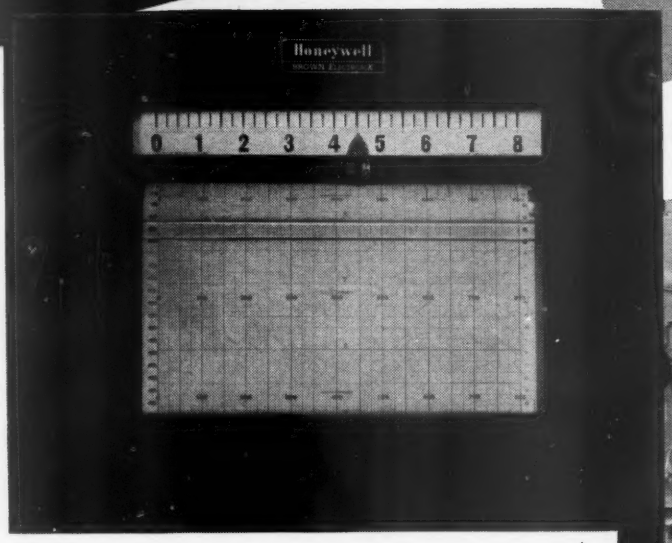


All Models Convertible to ALL Attachments!

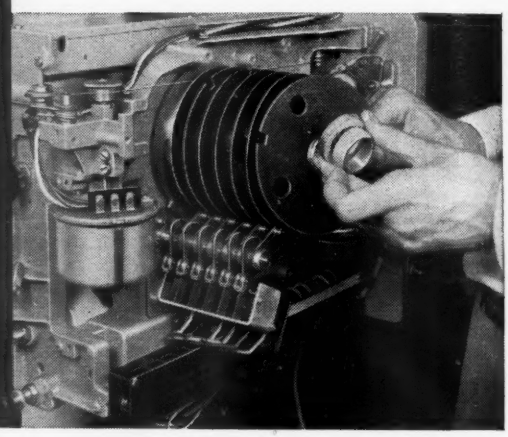
To obtain more information on products advertised see page E-51

WATCH HOT SPOTS in pipeline stations...

with an ElectroniK SIGNALLING RECORDER



16 temperatures in motors and pumps are concentrated on this ElectroniK Recorder.



Up to 8 Micro alarm switches and operating cams can be supplied in the instrument—each adjustable to operate alarms at different temperatures.

PIPELINE pumping stations can now insure against overheat failure of pumps and motors —by assigning an *ElectroniK* temperature recorder to the job of watching critical points.

A single instrument records as many as 16 separate temperatures in motor windings, bearings, pump glands and cases . . . scanning through successive points at a speed of five seconds per point. On the 11-inch wide chart, operators can easily see every temperature variation . . . can spot dangerous upward trends and take corrective action before serious damage occurs.

As many as eight different temperature limits can be established for the various points covered. One temperature can be selected for motor bearings, another for windings, another for pump glands. If any point exceeds the limit set for it, the instrument automatically actuates a horn, bell or signal light.

Where vital pumping equipment is at stake, the rugged design and time-tested components which typify all *ElectroniK* recorders are your constant guarantee of continuous, dependable performance. Your local Honeywell engineering representative will be glad to discuss how you can safeguard your pumping stations. Call him today . . . he is as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4475 Wayne Ave., Philadelphia 44, Pa.

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● *Important Reference Data*

Write for Instrumentation Data Sheet No. 7.2-4, "Protection of Pipeline Pumping Units Against Excessive Temperatures."

NEWS

Pipe Line Revenues and Traffic Volume Increase

The accompanying table shows for the years 1941-1951 the transportation revenue and the number of barrels of oil originated on line and received from connections as reported by large oil pipe line companies subject to the jurisdiction of the ICC. The 1951 figures represent all time peaks.

Large oil pipe lines[1].

Year	Transportation revenue	Number of barrels of oil originated on line and received from connections Thousands
1941	$233,085,128	1,488,838
1942	227,967,538	1,619,579
1943	261,571,709	1,949,685
1944	290,293,589	2,235,400
1945	279,982,686	2,174,677
1946	273,326,620	2,107,417
1947	300,092,514	2,317,256
1948	342,534,525	2,559,912
1949	349,005,607	2,381,810
1950	408,585,889	2,672,780
1951	483,904,491	3,117,987
Per cent increase: 1951 over 1941	107.6	109.4

[1]Based on quarterly reports of oil pipe lines having revenues of more than $500 a year.

The transportation revenue of these lines increased 18.4 per cent in 1951 over 1950 and traffic volume was up 16.7 per cent. In comparison with the returns for 1941 (essentially a prewar year) the carriers' 1951 revenues were up 107.6 per cent and traffic volume increased 109.4 per cent. The marked postwar expansion in oil pipe line operations is indicated by the fact that in each of the five postwar years 1947-1951 the volume of traffic and the revenues reported to ICC exceeded those of the peak war year 1944. These increases in traffic and revenue are presumably attributable in part to a considerable postwar expansion of the pipe line network. Oil pipe line companies subject to the jurisdiction of the ICC reported a total of 111,615 miles of line operated (both trunk and gathering) at the close of the year 1944 as compared with 128,589 miles on December 31, 1950, or an increase of 15.2 per cent. Mileage figures for 1951 are not yet available.

The results of the operations of the "Big Inch" and "Little Inch" (government financed pipe lines) during the war years are not included in the figures in the table as these carriers did not report to the ICC during the war and were subsequently converted to natural gas lines. The larger proportion of oil transported by the "Big Inch" line during the war, however, was originated by carriers reporting to the ICC.

Texas Eastern Re-elects

Stockholders of Texas Eastern Transmission Corporation re-elected all members of the board of directors at the annual meeting recently. Those elected are George R. Brown, Herman Brown, George A. Butler, Chas. I. Francis, William A. Smith, Gus S. Wortham, all of Houston; E. DeGolyer, Dallas; Charles I. Thompson, Philadelphia, and R. H. Hargrove, Shreveport, Louisiana.

384,400 Tons Steel to Gas Lines Third Quarter

Six major natural gas pipe line projects with a total estimated construction cost of $215,898,000 have been given priorities assistance for purchase of line pipe for the third quarter of 1952, Secretary of the Interior Oscar L. Chapman announces. In addition, a large number of smaller gas projects also have been given priorities assistance by the Petroleum Administration for Defense.

There were 169,600 tons of pipe 16 in. or larger in diam allocated for the third quarter to the six major projects.

An additional 214,800 tons of pipe have been allocated to several hundred smaller projects, including gathering lines, distribution lines, other facilities, and MRO (maintenance, repair, and operations).

Total pipe allocated to date for the quarter is 384,400 tons.

The six large projects given priorities assistance, Deputy Petroleum Administrator Bruce K. Brown explained, are:

1. Extension and looping of the Texas-Ohio system of the Texas Gas Transmission Corporation to provide additional supply to present customers.
2. Looping of the existing Texas-California system of El Paso Natural Gas Company to provide additional gas for California.
3. Augmenting of the system of the Interstate Natural Gas Company to provide additional gas for Baton Rouge, Louisiana, industrial plants.
4. Construction of additional facilities into the Houston-Texas City area by the Houston Pipe Line Company.
5. Looping and extension of the Southern Natural Gas Company system for additional supplies to its entire market area.
6. Extension of the Texas-Eastern Transmission Corporation system to maintain the capacity of the present transmission system.

Details of the six major projects given priorities assistance for the third quarter of 1952 are the following:

Company	Estimated cost	Estimated completion date	Capacity cu ft per day	Third quarter, 1952 line pipe required
El Paso Natural Gas	$ 60,828,000	4Q52	200,000,000	46,200 tons
Interstate Natural	3,869,000	4Q52	110,000,000	10,400
Houston Pipe Line	2,400,000	4Q52	60,000,000	8,400
Texas Gas Trans. Corp.	46,126,000	3Q52	260,000,000	32,600
Southern Natural	77,675,000	4Q53	350,000,000	21,800
Texas Eastern Trans. Corp.	25,000,000	4Q52	200,000,000	50,200
Total major projects	$215,898,000		1,180,000,000	169,600
Other projects				214,800
Total line pipe allocations third quarter 1952				384,400 tons

Oil Pipe Lines Allocated 271,751 Tons Steel

Twelve large crude oil pipe lines and 11 large petroleum products pipe lines in the United States have received priorities assistance for third-quarter 1952 purchases of a total of 227,285 tons of line pipe, Secretary of the Interior Oscar L. Chapman has announced.

In addition, he said, the Petroleum Administration for Defense allocated to a large number of smaller projects—crude and products lines, terminals, small construction, and MRO (maintenance, repair, and operation)—a total of 44,466 tons of line pipe for the third quarter.

Total line pipe assigned to oil transportation for the quarter thus comes to 271,751 tons.

Estimated construction cost of the large crude oil pipe lines, which were assigned 101,018 tons for the quarter, is $116,697,000, Deputy Petroleum Administrator Bruce K. Brown explained. Estimated construction cost of the larger products lines, which were assigned 126,267 tons for the quarter, is $76,727,000. Total cost for all these larger projects is $193,424,000.

Total requirements of line pipe for which priorities assistance is needed are 343,117 for the crude lines and 184,729 tons for the products lines, a total of 527,846 tons.

Three of the larger crude lines are scheduled for completion in the third quarter of this year, the other nine for completion in the fourth quarter. One of the larger products lines is scheduled for completion in the third quarter, seven for completion in the fourth quarter, and three for completion in the first quarter of 1953.

Two of the larger crude line projects previously had been granted priorities assistance by PAD—the Sinclair Pipe Line Company project for a 683-mile 22 and 24-in. line from Drumright, Oklahoma, to Salisbury, Missouri, and Chicago, Illinois; the Shell Pipe Line Corporation's "Rancho" line, 463 miles of 24-in. line from McCamey to Houston, Texas. The ten other larger lines are receiving priorities assistance for the first time.

Three of the larger products lines also have received assistance in previous quarters — the 285-mile 14-in. line of Shell Oil Company from Wood River, Illinois, to Chicago and Argo, Illinois; the 316-mile 12-in. line of Standard Oil Company (Indiana) from Sugar Creek, Missouri, to Dubuque, Iowa; the 120-mile 8-in. line of Susquehanna Pipe Line Company from Fostoria to Randolph, Ohio. The eight other larger lines are receiving priorities assistance for the first time.

Details of the larger projects follow:

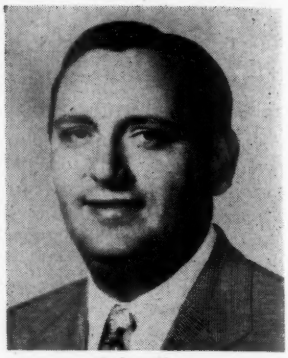
Major Crude Lines	Line pipe, tons	
	Total assistance required	Third quarter allotments
Sinclair Pipe Line Company..... 683 mi. 24 and 22 in. from Drumright, Okla., to Salisbury, Mo., and Chicago, Ill. Initial capacity—280,000 bbl per day. Estimated cost—$51,942,000 Estimated completion date—third quarter, 1952	144,055	10,000
Cities Service Pipe Line Company..... 64 mi. 18 in. from Sour Lake, Texas to Lake Charles, La. Initial capacity—150,000 bbl per day Estimated cost—$3,100,000 Estimated completion date—fourth quarter, 1952	8,625	8,616
Shell Pipe Line Corporation—"Rancho" 463 mi. 24 in. from McCamey to Houston, Texas area Initial capacity—209,000 bbl per day Estimated cost—$41,631,000 Estimated completion date—fourth quarter, 1952	129,458	51,898
The Texas Empire Pipe Line Company 29 mi. 18 in. Wilmington to Lockport, Ill. Capacity increase to area served—69,000 bbl per day Estimated cost—$1,546,000 Estimated completion date—fourth quarter, 1952	4,729	4,729
Service Pipe Line Company..... 33 mi. 16 in. loops between Bowie, Texas and Drumright, Okla. Capacity Increase—19,000 bbl per day Estimated cost—$1,980,000 Estimated completion date—fourth quarter, 1952	4,300	4,300
Pasotex Pipe Line Company..... 200 mi. 8 in. from Wink to El Paso, Texas Initial capacity—11,500 bbl per day Estimated cost—$3,283,000 Estimated completion date—fourth quarter, 1952	11,968	6,962
Magnolia Pipe Line Company..... 29.5 mi. 8 in. in Midland County, Texas Capacity increase—12,000 bbl per day Estimated cost—$575,000 Estimated completion date—fourth quarter, 1952	1,925	945
Interstate Oil Pipe Line Company..... 35.76 mi. 16 in. between Bunkie and Flora, La., for system revision Capacity—107,000 bbl per day Estimated cost—$2,935,000 Estimated completion date—fourth quarter, 1952	5,142	2,092
Service Pipe Line Company..... Lay 62 mi. 10, 8, 6, and 4 in. lines connecting six new areas in Lea County, New Mexico Capacity—45,000 bbl per day Estimated cost—$1,027,000 Estimated completion date— third quarter, 1952	3,912	552
Cooperative Refinery Association..... 46 mi. of 6 in. from Holdrege, Nebraska, to Phillipsburg, Kansas Initial capacity—5,000 bbl per day Estimated cost—$762,000 Estimated completion date—fourth quarter, 1952	2,006	2,006
Gulf Refining Company (Mesa System) 80 mi. 24 in. from Midland to Colorado City Junction with West Texas Gulf Line. Initial capacity—260,000 bbl per day Estimated cost—$5,582,000 Estimated completion date—fourth quarter, 1952	17,305	526
Toronto Pipe Line Company (Sterling System)..... 53 mi. 12 in. main line and 4, 6, 8, and 10 in. gathering lines from Logan County Colorado to Gurley, Nebraska Initial capacity—24,000 bbl per day Estimated cost—$2,334,000 Estimated completion date—third quarter, 1952	9,692	8,392
Shell Oil Company..... 285 mi. of 14 in. from Wood River, Ill. to Chicago and Argo, Ill. Initial capacity—85,000 bbl per day Estimated cost—$10,588,000 Estimated completion date—fourth quarter, 1952	36,917	6,238
Tuscarora Oil Company, Ltd..... 27 mi. of 12 in. between Allentown and Tuckerton Station, Pa. Part of an $8,398,000 rebuilding project between Allentown and Midland, Pa., which will give a 20,000 bbl per day capacity increase.	3,059	3,059
Bell Oil and Gas Corporation..... 145 mi. 8 in. and 6 in. from Ardmore to Drumright, Okla. Initial capacity—9,000 bbl per day Estimated cost—$3,270,000 Estimated completion date—first quarter, 1953	9,012	3,956
Phillips Petroleum Company..... 54.24 mi. 8 in. loops to Mextex line between Goldsmith and Borger, Texas Also 50 mi. 8 in. from Spraberry plant to Goldsmith Capacity increase—8,000 bbl per day Estimated cost—$2,729,000 Estimated completion date—fourth quarter, 1952	6,383	1,452
Standard Oil Company (Indiana)..... 316 mi. 12 in. from Sugar Creek Refinery to Dubuque, Iowa Initial capacity—40,000 bbl per day Estimated cost—$10,430,000 Estimated completion date—fourth quarter, 1952	33,180	27,180
Susquehanna Pipe Line Company..... 120 mi. 8 in. from Fostoria to Randolph, Ohio, and 3½ mi. 8 in. near Toledo, Ohio. Initial capacity—19,200 bbl per day Estimated cost—$3,095,000 Estimated completion date—fourth quarter, 1952	9,606	7,695
Phillips Pipe Line Company..... 35 mi. 6 in. from Okmulgee to Tulsa, Okla. Initial capacity—12,000 bbl per day Estimated cost—$566,000 Estimated completion date—fourth quarter, 1952	1,808	1,808
Pioneer Pipe Line Company..... 310 mi. 6 and 8 in. line from Sinclair, Wyoming, to Salt Lake City, Utah Initial capacity—12,000 bbl per day Estimated cost—$7,840,000 Estimated completion date—fourth quarter, 1952	21,639	21,639
Salt Lake Pipe Line Company..... 329 mi. 8 in. loops between Salt Lake City, Utah, and Boise, Idaho Capacity increase—17,000 bbl per day Estimated cost—$8,000,000 Estimated completion date—fourth quarter, 1952	19,790	9,905
Texas Pipe Line Company..... 198 mi. of 16 in. from Port Arthur, Texas to Baton Rouge, La., via Lake Charles, La, Initial capacity—96,000 bbl per day Estimated cost—$12,900,000 Estimated completion date—first quarter, 1953	28,451	28,451
Sinclair Pipe Line Company..... Harbor Products System 89 mi. of 16 in. from Philadelphia, Pa. area to New York Harbor area Also 14, 12, 8, and 4 in. feeder lines Initial capacity—11,000 bbl per day Estimated cost—$8,911,000 Estimated completion date—first quarter, 1953	14,884	14,884

Texas Eastern Microwave System Ready This Summer

Texas Eastern Transmission Corporation is constructing a multi-channel microwave system that will provide radio communication between the company's general offices in Shreveport, Louisiana, and all points along the company's new pipe line to Connellsville, Pennsylvania, and on to Linden, New Jersey, B. D. Goodrich, vice president and chief engineer, announces.

The new communication system, consisting of 56 microwave stations with towers varying from a height of 10 ft to 350 ft, is approximately 70 per cent completed. The microwave network is expected to be completed and in operation sometime this summer.

Goodrich stated that plans for the immediate future include installation of telemetering equipment to provide continuous and instantaneous metering information from any point along the new pipe line to the dispatching offices and the general office in Shreveport. Provisions have been made to permit addition of several hundred supervisory control and telemetering functions.



John Jipp

Motorola Opens New West Coast Department

Daniel E. Noble, vice president of Motorola's Communications and Electronics Division, announces the opening on June 1 of a new West Coast parts and service department. This new activity is headed by John Jipp, former sales manager of the division's southwestern states region.

Establishment of the new department offering parts and repair service to a nine state area will give customers and Motorola authorized service stations the same quality service now available east of the Rockies. The new office, at 811 South B Street, San Mateo, California, is completely equipped to handle parts and service on 2-way radio installations, microwave systems, power line carrier equipment, telemetering equipment, and remote supervisory control installations.

Jipp became associated with Motorola as a sales representative in 1945 after spending four years as a senior radio engineer in the Signal Corps Laboratories in Fort Monmouth, New Jersey, where he was responsible for the design and development of radio sets SCR-299, SCR-399, and SCR-499 for the Signal Corps.

Trans Desert Pipe Line Completed

Construction of the Iraq Petroleum Company's 556-mile, 30-in. trans-desert oil pipe line from Kirkuk, North Iraq, to Banias, the Mediterranean terminal, has been completed, six months ahead of schedule.

The Iraq Petroleum Company pioneered trans-desert pipe laying 20 years ago when it built twin 12-in. lines from Kirkuk to Haifa and Tripoli (Lebanon). The new 30-in. line, planned and designed five years ago, was begun in November, 1950, when American and British contractors began laying 160,000 tons of welded pipe imported from America.

First shipments of Kirkuk crude oil from the newly constructed Mediterranean terminal at Banias, Syria, began on April 11th. These shipments were made possible before the entire new line had been completed by connecting existing Haifa 12 and 16-in. lines (in disuse because of the Israel-Arab conflict) at K.3. pump station—a point 130 miles southwest of Kirkuk.

Permanent Offices Platte Pipe Line in Kansas City

At a meeting of the board of directors of the Platte Pipe Line Company held in New York City, it was determined that the permanent offices of the company would be established later in the year at Kansas City, Missouri. In order to avail the Platte Pipe Line Company of Sinclair Pipe Line Company's technical and operating services during the period of construction, however, it was decided that temporary headquarters would be maintained at Independence, Kansas, until completion.

The selection of Kansas City as the company's headquarters is based upon a survey made by Ford, Bacon and Davis, consulting engineers of New York City. The survey showed that Kansas City offered most in the way of operating economies and conveniences, not only to the Platte organization, but also to the five oil companies that own the line.

Platte Pipe Line Company, which is building a $60,000,000 crude oil pipe line extending from Wyoming to the Wood River area of St. Louis, and connecting with other lines in the Wood River area, is owned by British American Oil Company, Ltd., Continental Oil Company, The Ohio Oil Company, The Pure Oil Company, and Sinclair Pipe Line Company. The new pipe line, which passes just north of Kansas City, will be integrated with the new headquarters located there by the microwave communication and control system that is now being installed.

It is anticipated that the new headquarters will be opened in late summer or early fall of this year.

Jack Pate New President Western Pipe Liners Club

At the regular spring luncheon meeting of the Western Pipe Liners Club held at Lakewood Country Club, Los Angeles, J. B. (Jack) Pate, superintendent of the Union Oil Company Pipe Lines, Southern Division, was elected president for the ensuing year. E. L. Dreyer of The Texas Company, was elected vice president, and E. E. Cammack of Richfield Oil Company, secretary-treasurer.

These officers replace R. K. Paine of Standard, J. H. Robinson of Union, and F. O. McKeany of Shell.

Charles E. Bennett Elected President of AGA

Charles E. Bennett, president of the Manufacturers Light and Heat Company, Pittsburgh, Pennsylvania, has been elected president of the American Gas Association by the executive board to succeed the late George F. Mitchell, who died March 26. He has been vice president of association.

Frank C. Smith, president of the Houston Natural Gas Corporation, was elected to Bennett's former post of vice president of AGA.

Magnolia Petroleum Company on May 16 formally opened its new terminal and warehouse in Dallas, Texas, at the terminus of Magnolia Pipe Line Company's products pipe line from the Beaumont, Texas, refinery. Products are received in 16 storage tanks. The warehouse has 71,000 sq ft of space. Tank trucks receive their loads four at a time at the loading rack. A completely equipped automotive repair shop is also a part of the facilities.

Certificates of Necessity to More Pipe Line Companies

The Defense Production Administration has granted these pipe line companies additional certificates of necessity, giving them fast write-off, for tax depreciation purposes, of a certain proportion of the facilities cost:

Triangle Pipe Line Company, Corpus Christi, Texas, 25 per cent of $5,807,805.

Southern Natural Gas Company, Birmingham, Alabama, 25 per cent of $7,917,700.

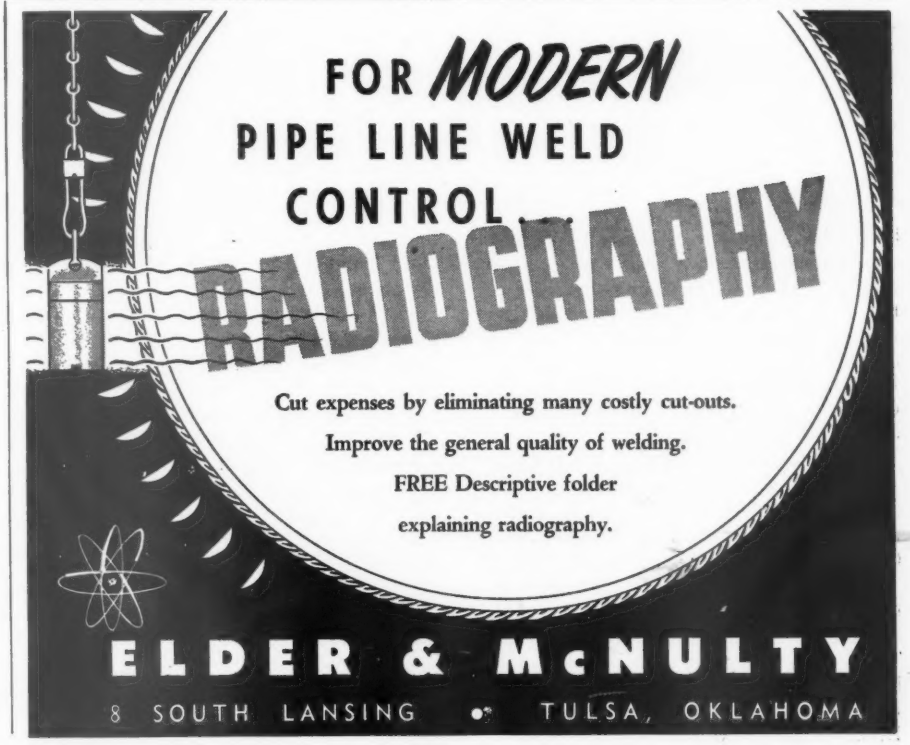
Pan American Pipe Line, Houston, Texas, 25 per cent of $4,089,000.

Pan American Gas Company, Houston, Texas, 25 per cent of $1,526,000.

Texas Eastern Transmission Corporation, Shreveport, Louisiana, 25 per cent of $98,900,843.

West Coast Pipeline Company, Dallas, Texas, 25 per cent of $60,000,000.

DPA offers fast tax write-off allowances to companies as a means of encouraging them to expand their facilities to produce defense and defense-supporting goods and services. A certificate of necessity allows a plant operator to depreciate his new facilities at a faster rate than ordinarily allowed by the Bureau of Internal Revenue. This has the effect of cutting his income tax payments during the first five years of his operation of the new facility.



Pipe Line Personals

Donald H. Lewis

Donald H. Lewis has been elected vice president of Shell Pipe Line Corporation by recent action of the board of directors, President T. E. Swigart announces. Lewis joined the Shell organization in 1927, has been chief engineer since 1939, and a director since 1942.

After graduating with a BS degree in mechanical engineering from Tri-State College of Engineering, Lewis did graduate work at the University of Besaucon (France) and completed the Allis-Chalmers graduate student training course. During World War I he served in France.

As a design and application engineer of the Allis-Chalmers Manufacturing Company (1920-27) he did pioneer work in the use of centrifugal pumps and electric power on trunk oil pipe lines.

Long active in the technical work of the American Petroleum Institute, Lewis is a member of its Committee on Pipe Line Technology and represents the Institute on inter-industry committees drafting oil and gas pipe line welding specifications and revising the American Standards Association B-31 Code of Pressure Piping.

Alan A. Cullman of Mountain Lakes, New Jersey, has been named deputy director of the Gas Planning Division of the Petroleum Administration for Defense and succeeded **Walter E. Caine** as director of the division. Cullman is on leave from his post as controller for the Columbia Gas System Service Corporation, New York City.

Caine, who has been with PAD since April 1951, leaves the agency to resume his position as vice president and treasurer of the Texas Eastern Transmission Corporation in Shreveport, Louisiana.

It was also announced that **Virgil F. Bowyer** of Pittsburgh, Pennsylvania, special executive representative with The Peoples Natural Gas Company, has been named assistant director of PAD's Natural Gas Production and Processing Division. Bowyer's post is a new one.

Oscar W. Morton has been named director of the Gas Operations Division of the Petroleum Administration for Defense, and **G. Barrett Herr** has been named director of the Gas Facilities Division, Secretary of the Interior Oscar L. Chapman announces.

Morton succeeds **A. Dale Greene** of Shreveport, Louisiana, while Herr succeeds **Louis C. Sonnen** of Houston.

Born in Dallas, Texas, Morton was a radio instructor for the Student Army Training Corps, Camp Martin, on the campus of Tulane University during World War I. In 1922 he joined Stone and Webster, Inc.

While with Stone and Webster he worked successively as engineer with the El Paso Electric Company, Baton Rouge Gas Company, City Gas Company of Norfolk, Virginia, and the Virginia Electric and Power Company of Richmond.

In 1931 he went with the Panhandle Eastern Pipe Line Company, Kansas City, Missouri, as manager of the rate department, then in 1946 was made vice president in charge of transmission operations.

Shortly after the beginning of the Korean hostilities in 1950 he went to Washington as gas consultant for the National Security Resources Board. In March of 1951 he joined the Gas Branch of PAD as a consultant, and in October of that year he was named assistant to the director of the Gas Operations Division.

Greene, whom he succeeds, is a native of Celina, Ohio. He received his bachelor's degree in civil engineering from Ohio State University in 1919 after serving as a pilot in the Army Air Service during World War I with the rank of second lieutenant, then became a construction engineer with the Pure Oil Company, Chicago. In 1928 he became a utilities engineer with the Columbia Engineering and Management Corporation, Columbus, Ohio, and stayed with the firm until 1930, when he became chief engineer for the United Gas Pipe Line Company with headquarters in Shreveport.

In 1946, Greene was made a vice president of United Gas, the position he held when he came to PAD on leave in June 1951.

Herr has been deputy director of PAD's Gas Facilities Division since early March, when he came to the agency on leave from his position as superintendent of stores for The Peoples Natural Gas Company of Pittsburgh.

Born in Oil City, Pennsylvania, he has been associated with various phases of the oil and gas industries ever since his graduation from Findlay, Ohio, High School in 1916. He joined The Peoples Natural Gas Company in 1923 and has been with the firm since that time, serving as chief district field supervisor, supervisor of priorities during World War II, traveling field supervisor, and superintendent of stores. Herr has been active in the Materials and Supplies Committee of the American Gas Association for the last eight years, and for three years he was chairman of the committee.

Sonnen joined the PAD staff in April of 1951, on leave from his post as vice president in charge of purchasing for the Tennessee Gas Transmission.

Born in Houston, Texas, he was associated with the Eschlinger-Misch Company of Detroit, Michigan, before being employed by Tennessee Gas. He was in charge of materials purchases for the latter company for ten years before joining PAD.

Cornelius van den Berg, vice chairman of the board of the Southern Natural Gas Company, Birmingham, Alabama, has resigned from the Gas Industry Advisory Council, Department of the Interior. Van den Berg submitted his resignation in view of the fact that **C. P. Rather,** president of Southern Natural, was named to the council upon his recent resignation as assistant deputy administrator of the Petroleum Administration for Defense in charge of the Gas Branch.

The Gas Industry Advisory Council advises and counsels the secretary of the interior and PAD on gas matters involved in defense mobilization.

James T. Trimble, district chief clerk of the Interstate Oil Pipe Line Company, has been transferred from the Sunset district to Bunkie, Louisiana. He is now working in the right-of-way department.

James E. Allison, who has been on leave from Texas Gas Transmission Corporation since last July while serving with the Petroleum Administration for Defense in Washington, D. C., will return to his company July 1. His duties have been with the Gas Facilities Division of PAD. He was an assistant superintendent in the pipe line department of Texas Gas before joining PAD.

Thomas A. Pofahl recently was promoted to assistant superintendent of the compressor department of the El Paso Natural Gas Company. His headquarters are in the home office at El Paso, Texas.

A. G. Stewart, formerly sub-foreman, has been promoted to district foreman at Blanco field in the San Juan division.

James W. Cronenberg, formerly senior engineer, is now assistant treating plant superintendent at Jal, New Mexico.

Walter C. Turner has been promoted to district foreman of the Angel Peak area in the San Juan division.

Pipe Line Personals

Herman G. Hortsman has been appointed assistant to the president of Texas Gas Transmission Corporation. Previously he was director of sales and customer relations. He has been active in the utility field for 30 years.

Everett O. Stoothoff has been appointed assistant secretary of the company. He joined Texas Gas in January of this year and formerly was assistant secretary of the Chemical Bank and Trust Company, New York.

Franklin K. Rader has been made supply contract representative to assist **Vice President B. C. Adams, Jr.**, with gas supply contract negotiations and related matters.

Paul E. Dufendach has been appointed assistant chief engineer and will aid **H. L. Stowers** with engineering matters before the Federal Power Commission and with engineering and economic studies on special projects. Dufendach has been associated with the natural gas industry for 20 years, with Louisville Gas and Electric Company, Kentucky-West Virginia Gas Company, and as a consulting engineer.

Clyde Watson has been named supervisor of public relations. He formerly was administrative assistant to U. S. Senator Thomas R. Underwood and the late Senator Virgil M. Chapman, both of Kentucky. Previously, he was associate editor of the Owensboro, Kentucky, *Messenger and Inquirer*.

T. A. van Griethuysen, manager of Continental Oil Company's crude oil trading department since 1948, has been promoted to the newly created position of coordinator of transportation and supplies, it has been announced in Houston, Texas, by **Chas. A. Perlitz, Jr.**, vice president. Van Griethuysen will continue to make his headquarters in Houston, and will be in charge of the company's motor transportation, traffic, and crude oil trading activities. An employee of Continental since 1929, he has been associated with the company's production and crude oil trading departments for the last 17 years. He is a graduate of the University of Oklahoma.

It was announced at the same time that **F. E. Butterfield,** assistant manager of the crude oil trading department since 1950, has been promoted to manager. Butterfield, whose headquarters will remain in Ponca City, Oklahoma, has held a succession of positions with Continental in Texas and Oklahoma over the last 22 years.

D. W. Sims and **P. H. Kuhns** will continue to manage Conoco's motor transportation and traffic departments, respectively, it was announced. Both have headquarters in Ponca City.

Ralph T. McElvenny has been elected executive vice president of the American Natural Gas Company and **John Dern** general counsel. McElvenny has served as financial vice president and assistant to the chairman, **William G. Woolfolk,** since 1945. Dern is a director of the company and its subsidiaries.

William S. Tarver, associate general counsel of the Petroleum Administration for Defense, has resigned to accept a position as general attorney for the Southern Natural Gas Company, Birmingham, Alabama.

Tarver joined PAD in April 1951, as assistant general counsel and was named associate last August.

Tarver joined PAD from the Federal Power Commission, where he was assistant general counsel. He holds a BS degree from Georgetown University and an LL.B. from Southeastern University. From 1927 to 1938 he was a reporter for the *Evening Star* in Washington, then served as Assistant United States Attorney for the District of Columbia until April 1941, when he entered private law practice.

M. E. Grant, manager of transportation and supplies for Shell Oil Company, will become executive vice president of Plantation Pipe Line Company, Atlanta, July 1. He will be succeeded by **R. N. Duncan,** manager of the supplies department. **M. H. W. Dent,** now assistant manager of supplies, will become manager in Duncan's place, and will be succeeded by **C. M. D. Peters.**

Grant is a graduate of the University of Missouri law school. He started work with Shell 22 years ago in St. Louis, where he handled insurance, legal, and traffic assignments. He was transferred to New York City in 1940.

Lee T. Cameron, employee of Interstate Oil Pipe Line Company, will begin an assignment in June with Creole Petroleum Corporation in Venezuela on the Amuay Bay pipe line project. He will be a welding and coating inspector. Already on loan to Creole are **Jay E. Thompson,** and **Kenneth Matthews,** engineers; **Douglas A. Holt,** chief inspector; **C. S. Ogle** and **J. R. Crawford,** inspectors, and **A. K. McKinney,** welding and coating inspector.

Louis A. Panzer has been made district foreman of the South Omaha district of the Lincoln Pipeline Division of Northern Natural Gas Company. He succeeds **Ralph Cotton** who has been transferred to Clifton, Kansas, as division superintendent. Panzer has been employed by Northern Natural for 15 years.

Mark Connolly and **Joe McCorkle,** of Ajax Pipe Line Company, and **W. L. Nash,** of Interstate Oil Pipe Line Company, left in May on loan assignment to the Interprovincial Pipe Line Company to assist with that company's looping project. Connolly will serve as spread inspector, McCorkle as welding inspector, and Nash as coating and wrapping inspector. They will join Ajax employees **Lester Miller** and **Mervin Henderson,** who are presently on loan to Interprovincial and Lakehead Pipe Line Company, respectively.

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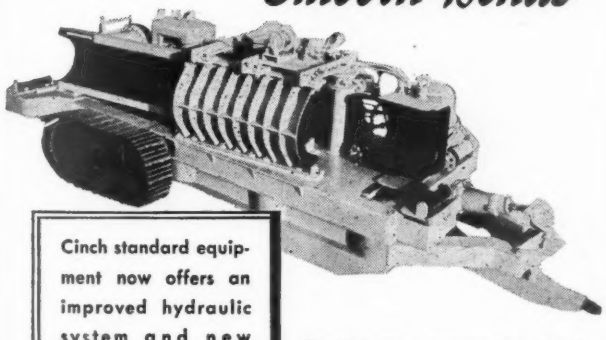

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To obtain more information on products advertised see page E-51

PIPE LINE PROJECTS

Products Line Beaumont to Newark Approved

The Petroleum Administration for Defense has given approval to the United States Pipe Line Company, Houston, Texas, for construction of a products pipe line system from Beaumont, Texas, to Newark, New Jersey. PAD said it would recommend 25 per cent accelerated tax amortization but would offer no priority assistance for line pipe or materials. Such assistance will be withheld until the pipe line company shows firm arrangements on engineering, financing, and commitments for products to be transported. The date for the presentation of such information has been set at July 15.

The pipe line, which would be approximately 1000 miles in length, would be 16 in. in diam from Beaumont to Cincinnati, and 14 in. on to Newark.

Sun to Construct West Texas Facilities

Two new pipe lines to fill gaps in its West Texas facilities are planned by Sun Pipe Line Company (Pennsylvania) this year.

The projects to be completed by the wholly-owned subsidiary of Sun Oil Company are a 13-mile section between the Cogdell area and Sun Oil Company's Brice Lease in the Snyder area and a 34-mile line north from Jameson field to West Texas Gulf terminal near Colorado City.

The improvements will give Sun a 200-mile pipe line system in West Texas.

As one of the owners of the 26-in. West Texas-Gulf Pipe Line, now under construction, Sun will supply part of the crude to be transported by that pipe line.

The new lines will better Sun's supply, which will be piped as far as Wortham. Part of this will be divided and will go to Longview and the remainder will be delivered to Beaumont, Sun Oil reported.

The Longview crude will be delivered to the Mid-Valley Pipeline Company and transported to Sun's Toledo refinery. Crude received at Sun Station, near Beaumont, will be loaded aboard tankers and transported to Sun's Marcus Hook refinery.

The 13-mile link will connect the Salt Creek area of Kent County into the Snyder system, which now gathers all of Sun's Scurry County production and delivers it to the Colorado City terminal of the Basin System.

The 34-mile line from Jameson will provide for the delivery of all of Sun's Coke County production into the Colorado City terminal. This crude is now being transported by other pipe line companies, but will be diverted to West Texas, Gulf Pipe Line upon the line's completion.

A. H. Johnson, area superintendent at Snyder, administers Sun Pipe Line Company's sizable West Texas system.

Mississippi River Fuel Asks Compressor Increase

Mississippi River Fuel Corporation, St. Louis, Missouri, is seeking Federal Power Commission authorization for the construction of 17 additional compressor units totaling 13,385 hp in 7 existing compressor stations and one new station on its natural gas transmission system.

Mississippi said that the additional compressor facilities would increase its rated daily sales capacity to 450,000,000 cu ft. Estimated cost of the project is $2,019,754.

Two of the additional units would be purchased and installed by Mississippi, and the other 15 units are proposed to be removed from existing stations in Louisiana and relocated and installed at stations in Arkansas and Missouri. The one new station is to be near Ste. Genevieve, Missouri. Mississippi also proposes to abandon 1500 hp of compressor units no longer in serviceable condition.

Asks FPC to Authorize 31-Mile Line in Kentucky

Morganfield Natural Gas Company, Morganfield, Kentucky, has filed an application with the Federal Power Commission requesting authorization to construct a 31-mile lateral natural gas transmission line extending to Morganfield from a proposed line to be built by Texas Gas Transmission Corporation, of Owensboro, Kentucky.

The line, to be of 4 and 6-in. diam pipe, would also pass through Sturgis, Providence, Clay, Diamond, Wheatcroft, and Sullivan, all in Kentucky. The Morganfield company plans to sell gas at wholesale to the Cities of Providence and Sturgis, and at retail in the other communities through which the line would pass.

Estimated cost of the entire project, including distribution facilities in the towns to be served at retail, is $1,075,000. The lateral line alone is estimated to cost $580,000.

United Gas Applies for Line to Off-Shore Field

United Gas Pipe Line Company, Shreveport, Louisiana, has applied to the Federal Power Commission for authority to build about 31 miles of natural gas transmission line extending from an off-shore field of the Gulf of Mexico to a connection with another pipe line now under construction by the company in Terrebonne Parish, Louisiana.

The proposed new line, to be of 20-in. diam pipe, would have a capacity of 165,000,000 cu ft of natural gas a day. Estimated cost of the project is $4,255,800.

United said that it has entered into a gas purchase contract with Phillips Petroleum Company, Kerr-McGee Oil Industries, Inc., and Stanolind Oil and Gas Company covering reserves of those companies in the Ship Shoal area off the Louisiana coast. At present there is no outlet for the gas produced from the blocks covered by the contract, the application states.

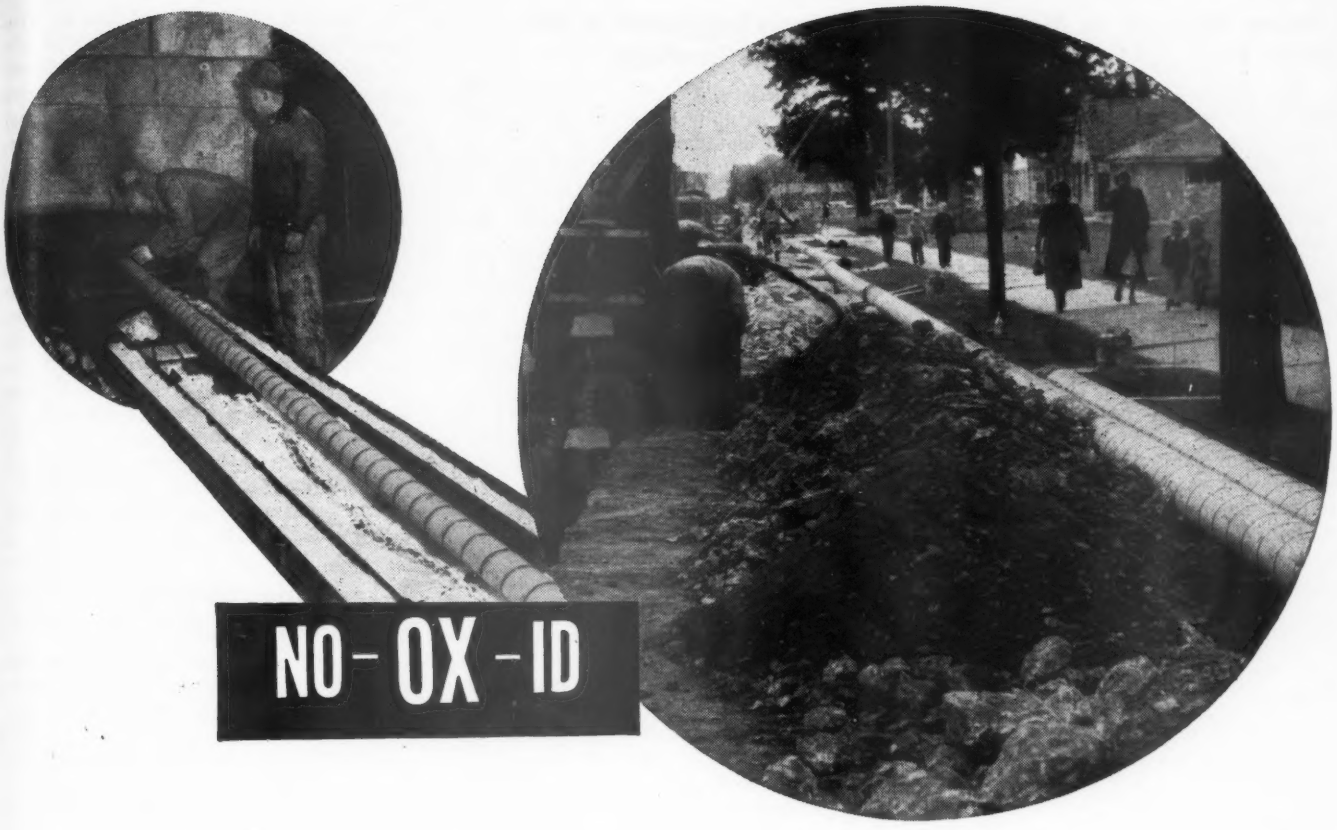
Construction of the proposed line, United asserted, would augment the reserves of gas available to its enlarged system by connecting a new source of supply. According to an exhibit submitted by United Gas Pipe Lines, the recoverable reserves in the area are presently estimated at 300 billion cubic feet.

United Fuel Plans West Virginia Program

United Fuel Gas Company of Charleston, West Virginia, has filed an application with the Federal Power Commission proposing the construction of natural gas pipe line facilities in West Virginia to expand its underground gas storage operations and to protect and replace existing transmission facilities.

The proposed construction program 21.5 miles of pipe line and a total of 4840 compressor horsepower. Total estimated cost of the project is $3,582,640, including $1,171,040 for acquiring and activating the storage fields.

United said that it now has 13 storage pools in depleted gas fields near its transmission system, and that it plans to acquire and activate 2 additional pools in Wood and Upshur counties, West Virginia. The remainder of the proposed construction program, including a new 880-hp compressor station and the additional 3960 hp at an existing station, would be carried out on United's system in the general area of Charleston.



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United Natural to Merge With Four Affiliates

The Federal Power Commission has authorized the merger of United Natural Gas Company with four affiliates—Ridgway Natural Gas Company, St. Mary's Natural Gas Company, Smethport Natural Gas Company, and Mercer County Gas Company.

The five companies, all wholly-owned subsidiaries of National Fuel Gas Company, and all with main offices in Oil City, Pennsylvania, will form a new corporation, also to be known as United Natural Gas Company. The five merging companies are at present officered and staffed by the same persons.

The new United Natural Gas Company plans to continue service to present customers of the merged companies without a change in rates. The FPC said that the consolidation of the five companies will result in more efficient and economic operations through the elimination of unnecessary duplication of facilities and administrative complexities.

Under provisions of the merger agreement, the presently outstanding capital stock of United and the other four companies will be exchanged for no par value common stock in the new merged and consolidated company.

United operates a pipe line system in Ohio and Pennsylvania, while the other four merging companies serve various communities in western Pennsylvania.

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Charges Suggested in FPC Filing Applications

The Federal Power Commission has issued a supplemental notice of proposed rule making that would amend the regulations under the Natural Gas Act relating to the form and filing of applications for certificates of public convenience and necessity.

The FPC's original notice of the proposed revision was issued March 6, 1951, and numerous suggestions and comments subsequently were submitted by interested persons. The commission said that all suggestions and comments have been carefully considered and, to the extent deemed pertinent and desirable, have been embodied in the proposed amendments.

The proposed changes generally are designed to help eliminate sketchy and incomplete applications requiring extensive correspondence to supply deficiencies by placing upon the applicant the burden of adequate presentation of certificate applications; to provide for the filing of abbreviated applications in the case of relatively minor operations, sales, service, construction, extensions, or acquisitions; and to provide general improvement in the form and content of applications.

Texas Eastern Plans 315 Miles 24-in. Line

Texas Eastern Transmission Corporation, Shreveport, Louisiana, has applied to the Federal Power Commission for authority to construct 315 miles of natural gas transmission line extending from a point near Provident City, Lavaco County, Texas, to Castor, in Bienville Parish, Louisiana.

The proposed 24-in. line, which is estimated to cost $25,943,079, would have a daily capacity of 200,000,000 cu ft of natural gas. A compressor station, with 5500 installed horsepower, would be constructed on the proposed line in Shelby County, Texas.

Texas Eastern said that no additional service would be rendered through the new line. The additional supplies of natural gas would be used in carrying out previously authorized service, the application states.

The southern terminus of the line, Texas Eastern said, is in one of the major gas producing areas of the Southwest which is being actively developed for additional production. Texas Eastern said it now purchases gas produced in this area, and is making arrangements for additional supplies there and in adjoining areas.

Amere Authorized to Lay 33 Miles of Line

The Federal Power Commission has authorized Amere Gas Utilities Company, of Charleston, West Virginia, to construct approximately 33.6 miles of pipe line in West Virginia to increase the capacity of its system.

Under the authorization, Amere will (1) build about 2 miles of line in Wyoming County to reinforce the gas supply to Mullens, West Virginia; (2) construct approximately 16.5 miles of line in Mercer County to supply additional requirements of Princeton and Athens, West Virginia, and to supply gas to Bluefield Gas Company, and (3) build approximately 15.1 miles of line in Raleigh and Mercer counties to transport gas from Atlantic Seaboard Corporation's Flat Top compressor station to Amere's existing line near Beckley, West Virginia. This line will permit Amere during off-peak periods to transport gas for Atlantic, purchased by that Company from Columbian Carbon Company, and also to take gas during peak periods from Atlantic for service to Amere's Beckley-Mullens market area.

The estimated cost of the proposed facilities is $802,340.

Texas-Ohio Hearing Scheduled for June 6

The Federal Power Commission has scheduled oral argument for June 6 in Washington, D. C., on a motion by the FPC staff counsel to dismiss the application of Texas-Ohio Gas Company, of Houston, Texas, proposing the construction of a Texas-to-West Virginia natural gas transmission line.

The staff motion was made during the course of the hearing on the company's application. The hearing, which began April 15, was adjourned by the commission April 17 until further order. The staff counsel contended that the company had failed to submit the necessary exhibits showing that it had a market for the gas it would transport through the proposed line, and asked that the application be dismissed without prejudice.

On April 28, Texas-Ohio filed an answer in opposition to the staff motion, while counsel for the coal and railroad intervenors filed a memorandum supporting the motion.

In a separate order issued May 14, the commission denied Texas-Ohio's petition asking reconsideration of the FPC order adjourning the hearing and requesting that a date be fixed for the hearing to be reconvened.

The commission also issued an order permitting the Reserve Natural Gas Corporation, of Cincinnati, Ohio, and the Public Utilities Commission of the State of Ohio to intervene in the proceeding.

Natural Gas Companies' Revenues and Income

Operating revenues of natural gas companies reporting to the Federal Power Commission totaled $181,324,641 in February, 1952, an increase of 12.6 per cent over February, 1951, receipts of $161,084,797. For the 12 months ended February 29, 1952, revenues aggregated $1,662,987,690 or 19.4 per cent higher than the $1,393,245,817 received in 12 months ending February 28, 1951.

Texas-Ohio Proposes Importing Mexican Gas

Texas-Ohio Gas Company, Houston, Texas, has filed applications with the Federal Power Commission requesting authority to import natural gas from Mexico, and for a Presidential Permit for the construction, maintenance, and operation of the facilities that would be used for the proposed importation.

FPC hearings on Texas-Ohio's pending application for authority to construct a natural gas transmission line extending from Texas into West Virginia were adjourned April 17 until further order of the commission, after the staff counsel filed a motion to dismiss the proceeding.

Texas-Ohio said that it plans to purchase 200,000,000 cu ft of natural gas a day from Petroleos Mexicanos, which owns and controls large gas fields in the State of Tamaulipas, Mexico. Petroleos Mexicanos would deliver the gas at the United States-Mexican border, at the southern terminus of Texas-Ohio's proposed gas line.

The gas would be produced in eight fields, all in Tamaulipas in northeast Mexico, which contain marketable natural gas reserves of more than 2 trillion cu ft, the application states. These reserves are dedicated to the purposes of Texas-Ohio's pipe line under the terms of a negotiated contract between the two companies, according to the application. Texas-Ohio said that while the contract has been written, it has not been formally executed.

Texas-Ohio's proposed 1439-mile, 30-in. pipe line, for which an application was filed last October, would originate at the Rio Grande River on the U. S.-Mexican border in Hidalgo County, Texas, and extend through Arkansas, Mississippi, Tennessee, Kentucky, and Ohio, terminating near Spencer, W. Va.

Texas Gas Expansion Hearing Set for June 16

The Federal Power Commission will hear oral argument June 16 in Washington, D. C., in the consolidated proceedings involving, among others, the application of Texas Gas Transmission Corporation, of Owensboro, Kentucky, to carry out an expansion program designed to supply additional natural gas to its present market areas.

The commission at the same time ordered the intermediate decision procedure omitted, which means that the case will be decided directly by the commission without the filing of an intermediate decision by the presiding examiner.

The omission of the intermediate decision procedure was requested at the hearing by Texas Gas and two subsidiaries, Texas Northern Gas Corporation and Louisiana Natural Gas Corporation, both of Lake Charles, Louisiana. Counsel for these companies also asked the simultaneous filing of briefs and that the commission hear oral argument in lieu of the filing of reply briefs. The examiner, however, set May 20 for the filing of main briefs and directed that reply briefs be filed by June 4. The commission ordered that briefs be filed as directed by the examiner.

The other companies whose applications are involved in the proceedings are Ohio River Pipeline Corporation, of Indianapolis, Indiana; Louisville Gas and Electric Company, of Louisville, Kentucky, and United Gas Pipe Line Company, of Shreveport, Louisiana. All applications, including those of the two Texas Gas subsidiaries, tie in with the Texas Gas proposal, in which that company plans to install a total of 26,860 hp in compressor capacity and to build about 407 miles of 26-in. loop line.

Hope Natural Would Construct 33-Mile Line

Hope Natural Gas Company, Clarksburg, West Virginia, has asked the Federal Power Commission for authority to construct a 33-mile pipe line in West Virginia and Virginia in order to procure additional supplies of natural gas for its transmission system.

The proposed line, estimated to cost $1,165,080, would connect with Hope's existing system in Wyoming County, West Virginia, and extend south to a point in Buchanan County, Virginia. Part of the gas to be transported through the proposed line would be purchased from independent producers in Buchanan County, with the remaining coming from Hope's own production now available in McDowell County.

Hope does not propose to serve any new markets or areas by means of the line, but said that it contemplates being able to render more adequate service to all its present customers.

The line, which would consist of 8, 10, and 12-in. diam pipe, would have a capacity of approximately 20,000,000 cu ft of natural gas a day.

Pipe Line to Storage Field Is Authorized

The Federal Power Commission has authorized the Sylvania Corporation, of Oil City, Pennsylvania, to construct pipe line facilities in the Tuscarora Storage Field in Steuben County, New York, in order to increase its ability to deliver natural gas from the field for the benefit of its affiliate, United Natural Gas Company, also of Oil City.

Under the authorization, Sylvania will replace about 12,000 ft of 8-in. and 6500 ft of 4-in. line with 12¾ and 6⅝-in. pipe, respectively, and install 400 additional horsepower at its Tuscarora storage compressor station.

The facilities are designed to increase Sylvania's ability to withdraw gas from the field from about 15,000,000 cu ft a day to about 96,000,000 cu ft. However, due to certain limitations of the facilities connecting the storage field to United's transmission system, the rate of withdrawal is not expected to be more than 25,000,000 cu ft a day.

More Horsepower and Line Mileage Granted

Cities Service Gas Company, Oklahoma City, Oklahoma, has received Federal Power Commission authorization to install an additional 1360 hp at two existing compressor stations in Oklahoma and Missouri and to construct 15.4 miles of 20-in. line to replace a 16-in. line in Kansas.

The new facilities include a 340-hp addition to the company's Welch compressor station in Craig County, Oklahoma; a 1020-hp addition to its Pierce City compressor station in Lawrence County, Missouri; and 15.4 miles of 20-in. line to replace the 16-in. line in Montgomery and Labette counties, Kansas.

Estimated overall capital cost of the project is $811,800, consisting of $545,000 for the 20-in. line and $266,800 for the compressor station additions.

The company said the facilities will increase the capacity of the Quapaw, Oklahoma-Springfield, Missouri, portion of its transmission system from 123,518,000 cu ft to 130,263,000 cu ft a day.

Cities Service also has been authorized by FPC to construct 21 miles of natural gas transmission line in Franklin and Anderson counties, Kansas, and to add a 1000-hp compressor unit at its Welda station in Anderson County.

The 21 miles of 26-in. line will replace two parallel 16-in. lines. The construction is estimated to cost $1,378,500, consisting of $1,160,000 for the 21 miles of line and $218,500 for the compressor station addition. Estimated cost of removal of parallel lines is $180,000.

The construction will increase by 36,000,000 cu ft a day the capacity of its system north of the Welda station, and will enable it to meet increasing demands in existing markets. Markets to be served from the new facilities are the Kansas City, Missouri, and Kansas City, Kansas, areas.

United to Connect With Underwater Field

United Gas Pipe Line Company, Shreveport, Louisiana, has received Federal Power Commission authorization for the construction of approximately 36 miles of pipe line to connect the company's natural gas transmission system with a new source of supply in an underwater field near Corpus Christi, Texas.

The new line, which will have a capacity of about 130,000,000 cu ft a day, will extend from a proposed purchase meter station for the Mustang Island (Red Fish Bay) field, offshore from Ingleside, Texas, to a connection with United's system near Refugio, Texas. Estimated cost of the facilities is $2,735,000.

United will purchase the gas from Sunray Oil Corporation. United estimates that there were 1,214.5 billion cu ft of gas in place in the field as of November 1, 1951. Of this, United's gas purchase contract with Sunray is estimated to cover 318.6 billion cu ft of gas.

With the PIPE LINE CONTRACTORS

Oklahoma Contracting Company, 6512 Hines Boulevard, Dallas, Texas, as a joint venture with Houston Contracting Company, is laying 68 miles of 24-in. between Houston and the Brazos River for the Rancho Pipe Line Company. One spread is working from a field office at 1100 Old Spanish Trail, Houston. Raymond Law is superintendent, Gene Gohring assistant superintendent, and Henry Turner office manager. A second spread has its headquarters at Pasadena, with Louis Visentine superintendent, "Buck" McIntyre assistant superintendent, and Dick Mueller office manager.

About 70 miles remain to be laid for United Gas Pipe Line Company in Texas. This work has been delayed awaiting right-of-way acquisition but will be resumed about the middle of June. Louis Visentine will move to Cleveland, Texas, to take charge.

Engineering-Construction Company, 402 North Cheyenne, Tulsa, Oklahoma, is just completing 68 miles of 4-in. through 16-in. for Cities Service Oil Company near Liberal and Ulysses, Kansas. This work began the early part of April. The field office was at Ulysses with John Mathews spreadman and Lloyd Evans office manager. Russell D. May is general manager and Lee Vaughan general superintendent.

Reece Brothers Construction Company, Hugoton, Kansas, has begun work on a 17-mile gathering system in the Hugoton area for Northern Natural Gas Company. Pipe sizes are 4, 6, 8, and 12-in. Paul Reece is general superintendent, Gale Reece spreadman, and C. D. Beighle office manager.

Houston Contracting Corporation, 2707 Ferndale Place, Houston, Texas, has the following under contract:

Approximately 220 miles of 22-in. crude oil pipe line for The Texas Pipe Line Company from the vicinity of Houma, Louisiana, to Port Arthur, Texas. This work is being handled by three spreads as follows:

67 miles of 22-in. from vicinity of Holmwood, Louisiana, west to Port Arthur, Texas. E. C. Norris, superintendent; R. E. Thornton, assistant superintendent; R. J. Axsom, field office manager. Headquarters are at Orange, Texas. A little more than half completed.

67 miles of 22-in. from vicinity of Holmwood, Louisiana, east to Gueydan, Louisiana, and from Morgan City, Louisiana, east to Houma, Louisiana. W. H. Hayes, superintendent; M. L. Thompson, assistant superintendent; J. C. Strickler, field office manager. Headquarters are at Morgan City, Louisiana. About half completed.

86 miles of 22-in. from vicinity of Gueydan, east to Morgan City. F. A. Silar, superintendent; C. V. Oliver, assistant superintendent; L. F. Redfearn, field office manager. Headquarters are at Franklin, Louisiana. A little more than half completed.

Approximately 95 miles, consisting of 30 miles of 12-in., and 65 miles of 6, 8, and 10-in. crude oil pipe lines for The Texas Pipe Line Company from Houma, south to and through the Terrebonne Bay vicinity. H. L. Leake, superintendent; S. B. Harrison, assistant superintendent; H. C. MacWhinnie, field office manager. Headquarters are at Houma. Approximately half completed.

Five major river crossings for The Texas Pipe Line Company from the vicinity of Morgan City, Louisiana, west to Orange, Texas. J. A. Cantrell, superintendent; J. B. Stoddard, field office manager. Headquarters, Orange, Texas. Four crossings completed.

Approximately 190 miles of 24-in. crude oil line for Rancho Pipe Line Company from a point west of Austin, Texas, to Shell Oil Company's Deer Park Refinery near Pasadena, Texas. This work is to be handled by two spreads, of which Oklahoma Pipe Line Constructors of Dallas, Texas, will put in the first spread to handle the 64-mile section from the Deer Park Refinery west to the Brazos River. This work recently got under way. A second spread will be put in by Houston Contracting Company to handle the 126-mile section from the Brazos River west to the vicinity of Austin, Texas. Preliminary work is expected to get under way about July 15.

Comstock Midwestern, Ltd., 206 Laird Drive N., Leaside, Ontario, is now in full operation on the Trans Mountain Pipe Line Company project between Edmonton, Alberta, and Vancouver, British Columbia. To lay 472 miles of the 693-mile total, this contractor is working four spreads, one east from Vancouver, two in both directions from Red Pass Junction, and one in the vicinity of Kamloops. Project headquarters are in Edmonton, Vancouver, and Jasper. C. C. Bledsoe is project manager for Comstock Midwestern and Charles Rathgeb, Jr., assistant project manager. Agents and engineer for Trans Mountain is Canadian Bechtel, Ltd.

The 24-in. line is scheduled for completion in the fall of 1953, and will have an initial capacity of 75,000 bbl a day.

Operations have reopened on the Sarnia Products Pipeline Company project, 120 miles of 6, 10, and 20-in. from London to Toronto, Ontario. The field office is at Woodstock, Ontario. Denver Franklin is superintendent.

Latex Construction Company of Georgia, Box 56, Northside Branch, Atlanta, Georgia, is constructing 32 miles of 20-in. pipe line from Bunkie to Melville, Louisiana, for Interstate Pipe Line.

Parkhill Truck Company (Stringing Contractor), P. O. Box 1856, Tulsa, Oklahoma, has the following jobs underway:

150 miles of 30-in. for Texas Eastern Transmission Corporation from Wheelersburg, Ohio, to Powhatan Point, Ohio, and 66 miles from Uniontown, Pennsylvania, to Moundsville, West Virginia. Contractor: Anderson Bros. Corporation. Foremen, Harrold Deatherage, O. C. York, C. A. Little, and Sidney Humphries.

280 miles 14-in. line and 320 miles of 8-in. take-up for Shell Oil Company, from Wood River, Illinois, to East Chicago, Indiana.

28 miles of 8-in. for Interstate Power Company from Clinton, Iowa, to Prophetstown, Illinois. Contractor: G. G. Griffis, Inc. Foreman, Frank Laubach.

100 miles of 16-in. and 125 miles of 3 to 8-in. scattered sections in Connecticut, Massachusetts, and New Hampshire for Northeastern Gas Company. Contractor: Bechtel Corporation. R. C. Parker, superintendent.

Approximately 60 miles of 30-in. for United Gas Pipe Line Company from Sterlington, Louisiana, to Clarence, Louisiana. Contractor: River Construction. Foreman, Charles Sampson.

Anderson Brothers Corporation, 6300 Navigation Boulevard, Houston, Texas, is working five spreads on 217 miles of 30-in. between Portsmouth, Ohio, and Connellsville, Pennsylvania, for Texas Eastern Transmission Corporation. The central office is at Athens, Ohio, with Dick Leonard general superintendent.

The spreads are as follows:

Oak Hill, Ohio—Emmett Wilkerson superintendent and Kelly Strickland office manager.

Athens, Ohio—A. B. Haynes superintendent and Jack Slack office manager.

Beverly, Ohio—Gene Coulter superintendent and C. C. Lazier office manager.

Caldwell, Ohio—Rusty Killingsworth superintendent and Russell McDowell office manager.

Waynesburg, Pennsylvania — Earl Saulsman superintendent and F. G. Hindman office manager.

The field office for the Rancho Pipe Line Company job has been moved to Big Lake, Texas. The section of the Rancho line being laid by this contractor extends from McCamey to Cedar Valley, Texas, 267 miles of 24-in. Aldress Kilgore is superintendent, Ned Swink assistant, and Karl R. Smith office manager.

A spread is working out of Fairfield, Texas, on the West Texas Gulf Pipe Line Company 26-in. system. Cooney Shiflett is superintendent, Bob McGee assistant, Fred Purvis office manager.

"Panama" Shiflett is general superintendent over all Texas spreads.

H. C. Price Company, Pipe Line Division, Box 1111, Bartlesville, Oklahoma, has a general contract with Brown and Root, Inc., covering construction of an indefinite number of miles of 30-in. high pressure natural gas pipe line for the Texas Eastern Transmission Corporation in the vicinity of Wheeling, West Virginia. Spreads are the following:

Moundsville, West Virginia, Box 383, telephone 1898: R. K. Shivel, superintendent; W. R. Crego, office manager; J. D. White, right-of-way foreman; W. H. Olrich and Ray Drewell, ditch; J. H. Latham and Virgil Huff, bending; Delbert Shivel, pipe; R. L. Ezell and John Stokes, welding; J. B. Northcutt, coating; C. W. Sisco, lower-in; Sam Price, clean-up; Cleo Robertson, road crossing, and Tommie Stammer, chief mechanic.

Woodsfield, Ohio, Box 540, telephone 6511: C. R. Ice, superintendent; G. A. Harvey, office manager; W. O. Elliott and Jessie Cash, right-of-way foremen; E. W. Whisenant, ditch; Forest Loinette, bending; W. T. Dickerson, pipe; L. O. Reutzel, welding; N. D. Adams and Henry Hill, coating; J. C. Rich and Bill Buchanan, lower-in; John E. Hamilton, clean-up, and Cliff Birmingham, chief mechanic.

A general contract also has been made covering construction of approximately 363 miles of 26-in. high pressure natural gas loop lines for Texas Gas Transmission Corporation from east bank of Mississippi River near Greenville, Mississippi, to Jeffersontown station, Kentucky, a few miles east of Louisville. Start of the work is awaiting authorization from Federal Power Commission in Washington.

A contract has been signed with Tennessee Gas Transmission Company for the construction of 80 miles of 26-in. pipe line in the state of Ohio. The contract covers two loops that will parallel the present TGT line that now stretches from southwest Texas to New England. These loops consist of 24 miles starting north of Carrollton, Ohio, and extending southwestward into Harrison County, and 56 miles starting northeast of Athens, Ohio, and extending southwestward into Jackson County.

A spread under Superintendent G. A. "Abe" Reutzel has been moved from Auburn, New York, to Carrollton, Ohio, to handle construction of these loops. R. W. Orr is foreman in charge of the welding gang. The office number at Carrollton is 92-J.

Mahoney Contracting Company, 2300 North Grand Avenue, Lansing, Michigan, has resumed work on the Michigan Gas Storage Company project after being shut down for several months due to cold weather. The original contract called for the laying of approximately 90 miles of 12-in. through 22-in. between Laingsburg and Mt. Clemens, Michigan, about half of which remains. The field office is at Rochester. Henry Mogg is spreadman.

Anderson Brothers of Venezuela, C. A., 6300 Navigation Boulevard, Houston, Texas, will install the Gulf of Coro crossing in Venezuela for Creole Petroleum Corporation. The crossing will consist of approximately 80,000 ft of 26-in. pipe. The field office will be at Las Piedras.

Conyes Construction Corporation, 2884 San Pablo Avenue, San Pablo, California, has contracted to take up 318 miles of 10 and 12-in. pipe and lay 328 miles of 8, 10, and 12-in. in the states of Ohio, Illinois, and Indiana for Ohio Oil Company. The take-up has been subcontracted to Trojan Construction Company. Work is expected to get underway about June 15 with the central office at Muncie, Indiana. Al Poggie will be the general superintendent. There will be two spreads, one at Martinsville, Illinois, with M. A. Norwood spreadman. The second spread will be in Ohio but the exact location and personnel have not been announced.

Canadian-Parkhill Pipe Stringing, Ltd., Toronto, Canada, will string approximately 200 miles 6, 10, and 12-in. for Imperial Oil, Ltd., from Sarnia to Toronto, Canada. Contractor, Comstock-Midwestern, Ltd. Superintendent, Curtis Williams.

469 miles of 24-in. for Trans Mountain Oil Pipe Line from Acheson, Alberta, to Burnaby, British Columbia. Contractors: Comstock-Midwestern, Ltd., and Canadian Bechtel. Superintendent, Jack Williams.

360 miles of 10-in. for Trans-Northern Pipe Line Company from Hamilton, Ontario, to Montreal, Quebec, Canada. Contractors: Sparling and Davis Company, Ltd., and Williams Brothers Company.

R. B. Potashnick, Cape Girardeau, Missouri, is scheduled to begin June 1 taking up 246 miles of 8-in. and laying 276 miles of 14-in. for Shell between Wood River, Illinois, and East Chicago, Indiana. One spread will have its headquarters at Peotone, Illinois. This spread under "Peanuts" Kinkaid, will begin about June 1 to lay 36 miles of 14-in. The rest of the work will start about July 1. Roy Whitworth's spread will work out of Litchfield, Illinois, and Arkie Hobson's out of Decatur, Illinois. Treece Boyd is general superintendent over all work.

River Construction Corporation, 6100 Camp Bowie Boulevard, Fort Worth, Texas, is laying an undetermined amount of 30-in. pipe as a part of United Gas Pipe Line Company's expansion program. Spreads are as follows:

Monroe, Louisiana — Merle Tatom superintendent and Earl Nevins office manager.

Natchitoches, Louisiana—H. J. "Red" Tatom superintendent and Lee Price office manager.

Jasper, Texas—Jimmy Reid superintendent and Pat Rogan office manager.

Livingston, Texas—Barney Hall, general superintendent.

Williams Brothers Corporation, National Bank of Tulsa Building, Tulsa, Oklahoma, will begin work in June on 160 miles of 26-in. pipe line for Creole Petroleum Corporation, according to present plans. The line will extend from Ule station on the east side of Lake Maracaibo to Amuay Bay. Marvin Jones will be in charge.

Approximately 143 miles of 10, 24, and 26-in. pipe is under construction for Algonquin Gas Transmission Company in New York, New Jersey, and Connecticut. The central office is at Danbury, Connecticut, with R. L. Buck the general superintendent and R. E. Higginbotham office manager. Spread offices are as follows:

Denville, New Jersey—O. R. Mitchell superintendent and J. E. G. Jester office manager.

Suffern, New York—Whitey Martin superintendent and Joe Mackie office manager.

Waterbury, Connecticut—T. E. Davis superintendent and Walt Smeltz office manager.

Thirty miles of 26-in. is under construction in the City of Minneapolis for the Minneapolis Gas Company. This is Dresser coupled line. W. F. Caldwell is superintendent and Sam Davis office manager.

At Gastonia, North Carolina, 14 miles of 3, 4, and 6-in. pipe was scheduled to get underway June 1 for Public Service Company of North Carolina.

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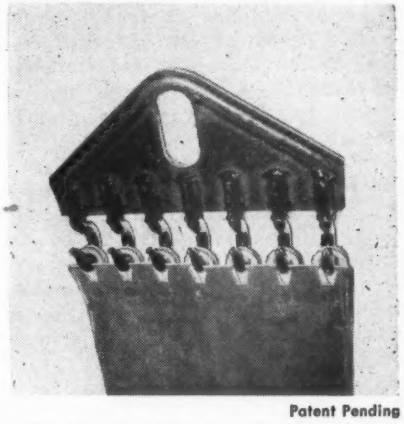

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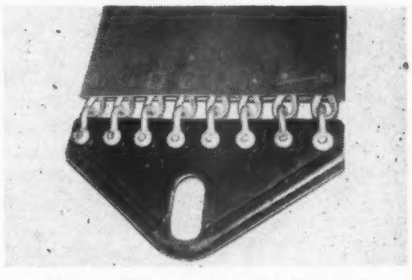

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Pipe Line Contractors

Bechtel Corporation, 220 Rush Street, San Francisco, California, has been awarded a contract by Northeastern Gas Transmission Corporation to lay 225 miles of 3, 8, and 16-in. pipe in Connecticut, Massachusetts, and New Hampshire. The central office is at Plainville, Connecticut. R. L. Bowman is general superintendent and W. H. Molander office manager. The spread offices are as follows:

Plainville, Connecticut—Vic Williams spreadman.

Stamford, Connecticut — Joe Work spreadman.

Derry, New Hampshire—Dick Alexander spreadman.

Clinton, Massachusetts—Slim Roberts spreadman.

R. H. Fulton and Company, P. O. Box 1526, Lubbock, Texas, has contracted to lay 100.7 miles of 26-in. in four loops for Northern Natural Gas Company as soon as FPC gives approval. A 30-mile loop will be laid east of Sublette, Kansas; a 25.5-mile loop north of Mullinville, Kansas; a 22.6-mile loop north of Clifton, Kansas, and a 22.6-mile loop north of Beatrice, Nebraska.

On the 180 miles of 24-in. for Sinclair Pipe Line Company between Humboldt, Kansas, and Salisbury, Missouri, one spread is making its headquarters at Iola, Kansas, and the other at Warrensburg, Missouri. The former has M. L. Boyd as superintendent and Vance Albers as office manager, while the latter has Jerry Nash in charge and Chuck Siewart office manager.

The field office continues at Scottsbluff, Nebraska, for work on the Platte Pipe Line Company's system, 443 miles of 20-in. being laid by this contractor, from Casper, Wyoming, to Holdrege, Nebraska. A. A. Carrigan is superintendent and Dave Wagner office manager.

O. R. Burden Construction Corporation, 6702 East 21st Street, Tulsa, Oklahoma, is nearing completion of its work for Sinclair Pipe Line Company between Cushing, Oklahoma, and Humboldt, Kansas. The field office is now at Bartlesville, Oklahoma. Floyd Lewis is superintendent.

Meanwhile this contractor has begun on another section of the Sinclair line, 176 miles of 22-in. from Key station near Salisbury, Missouri, to Forest City station, Illinois. The field office is at Huntsville, Missouri, with Dick Jernigan superintendent and Walt Hill office manager.

Take-up and reconditioning of 386 miles of 8-in. and 45 miles of 12-in. for Sinclair is underway between Salisbury, Missouri, and Wood River, Illinois. Earl Ditzenburg is in charge of the work and Guy Carder is managing the field office, which is at Mexico, Missouri.

The field office remains at Carrollton, Missouri, for work on the 120 miles of 20-in. being laid for Platte Pipe Line Company. B. W. Moore is superintendent, and Howard Smith office manager.

Midwestern Constructors, Inc., 105 North Boulder, Tulsa, Oklahoma, has been awarded the contract to construct the pump station at Quincy, Illinois, on Sinclair Pipe Line Company's new system between Cushing, Oklahoma, and East Chicago, Indiana. Another recent contract calls for manifold alterations at Hastings and Truro, Iowa, for Natural Gas Pipeline Company of America.

An 89,000-ft water line is being laid for The Texas Company from the Kaskaskia River to the Salem field, Illinois. Mac Hoffman is superintendent of this work, K. L. Kreamalmyer engineer, and Robert E. Klang office manager.

Work continues on the fabrication and installation of process piping at Bauxite, Arkansas, for the Aluminum Ore Company. Earl S. Powell is superintendent, F. C. Snavely, Jack Graham, and Elwood Rolf area superintendents, and Morris Garey office manager.

Installation of compressor units at Tuscola, Illinois, and Edgerton, Indiana, for Panhandle Eastern is completed.

Western Construction Company, P. O. Box 1135, Hobbs, New Mexico, is laying 105 miles of 8-in. for Continental Pipe Line Company between Port Isabel and the Rincon field, Texas. The field office is at Harlingen. Morris Lassley is superintendent.

Smith Contracting Corporation, 205 Northwest Seventh Street, Fort Worth, Texas, is laying 176 miles of 16-in. pipe line for The Texas Pipe Line Company, from Corsicana to Houston, Texas. The north spread, which is laying the 88 miles between Corsicana and Madisonville, is about to complete its work and likely will have done so by the time this goes to press. Last field headquarters were at Madisonville with Frank Craig spreadman and M. E. Williams office manager. The south spread is working out of Conroe, with H. E. Doyle spreadman and John Briggs office manager. Art Renton is engineer and purchasing agent for both spreads.

Mannix, Ltd., Calgary, Alberta, Canada, was scheduled to begin work June 1 on 221 miles of 24-in. for Trans Mountain Oil Pipe Line Company. This is the center section of a 693-mile line from Edmonton to Vancouver. Cal Baker is general superintendent and Jimmie Williams spreadman.

Vaughn and Taylor Construction Company, Inc., Box 1351, Wichita Falls, Texas, began constructing a 268-mile gathering system May 15 for Phillips Petroleum Company. The system is in the Spraberry field, Midland County, Texas, and will consist of pipe of 2 in. through 30 in. The field office is at Odessa; telephone: 7-2091. D. D. Vaughn is general superintendent and C. E. Sayles office manager.

Another job for Phillips is near Stinnett, Texas, being 11 miles of 3½-in. The work is being handled out of the company's branch office at Dumas. J. F. Crawford is superintendent.

Trojan Construction Company, 1416½ North Robinson, Oklahoma City, Oklahoma, is taking up 350 miles of 10 and 12-in. pipe for the Ohio Oil Company in Indiana and Ohio, some of which is being reconditioned. A field office has been set up at Lebanon, Indiana. Charles T. Tillotson and Maurice Crawford are superintendents and Don L. Wilson office manager.

Fulton and Brodie Construction Company, P. O. Box 2064, Amarillo, Texas, are constructing 142 miles of 20-in. pipe line for Platte Pipe Line Company, from Holdrege to Odell, Nebraska. The field office is at Fairbury, Nebraska. J. T. Brodie is superintendent, Clyde Peters spreadman, and Mrs. J. T. Brodie office manager.

Williams-Austin Company, Grant Building, Pittsburgh, Pennsylvania, is doing the following work for the New York State Natural Gas Corporation:

20 miles 20-in. pipe line from Angelica to Rossburg, New York. Began April 15. Warehouse in Belfast, New York, phone 188-R-1. I. E. Crosby, timekeeper, H. C. Bauer, superintendent.

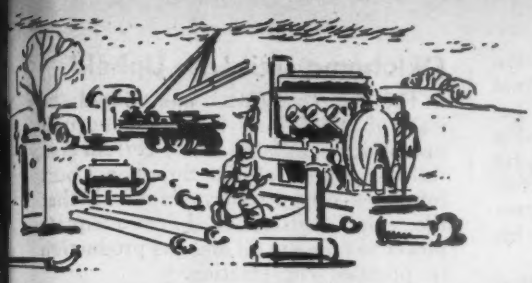
20 miles 20-in. from Cayuta Gate to Ithaca, New York. Start after completion of Angelica-Rossburg job. Warehouse to be located in Ithaca, New York. H. C. Bauer, superintendent. Clearing right-of-way now being done.

52 miles 16-in. pipe line from Utica to Amsterdam, New York. Start about June 1. Warehouse in Herkimer, New York. Ralph Gaddy, superintendent.

17 miles 16-in. pipe line from Colesburg Junction to Sabinsville, Pennsylvania. Clearing of right-of-way now being done. R. H. Condry, timekeeper, Warehouse at Coudersport, Pennsylvania, phone 683.

Anderson International Contractors, Ltd., Room 30, Miller Building, Edmonton, Alberta, Canada, was scheduled to get underway June 1 on 100 miles of 16-in. for Interprovincial Pipe Line Company near Regina. This is a loop in the central portion of Interprovincial's system. Joe Johnson will be general superintendent with headquarters at Edmonton. The field office will be at Glenboro, Manitoba, where L. C. Overmiller will be office manager.

J. L. Cox and Son, Raytown, Missouri, (Stringing contractors), will start soon hauling 386 miles of 8-in. and 46 miles of 12-in. pipe taken up by O. R. Burden Construction Corporation between Shannondale and Wood River, Illinois, for Sinclair Pipe Line Company. Stringing will begin soon on 175 miles of 22-in. pipe for Sinclair between Salisbury, Missouri, and Forest City, Illinois. Twenty miles remained (May 19) of the 24-in. being strung on the Sinclair system from Cushing, Oklahoma, to Humboldt, Kansas. Burden is general contractor for both of the latter jobs. Between Polo and Kenmoor, Missouri, 60 miles of 20-in. remain to be strung on the Platte Pipe Line Company system.



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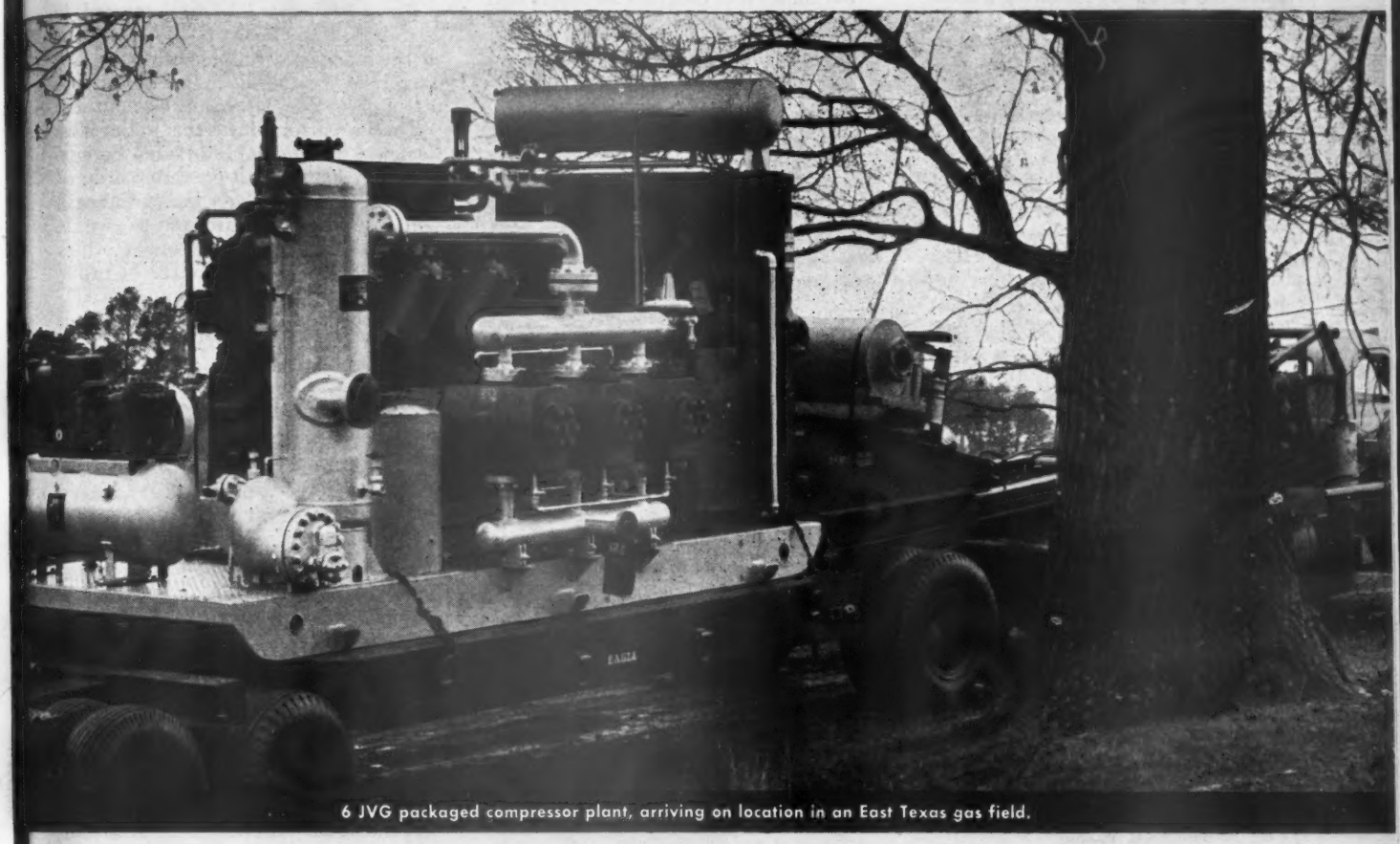

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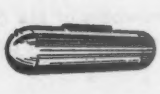

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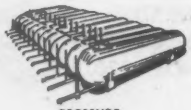

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NEWS

Phelps Warns No Price Rise In Sight for Oil Industry

The Independent Petroleum Association of America has launched another drive for a price raise for petroleum products but members attending a meeting of the group have been told that the Office of Price Stabilization "intends to hold the line" on crude oil prices. Speaking to the members was Edward F. Phelps, Jr., director of price operations for OPS, asserted no price relief is in sight for the oil producers.

Talking to members of the Empire State Petroleum Association, Cecil Burrill, PAD program division director, said adequate supply of oil to the East Coast is being hampered by price regulations on these products. He warned that companies who supplied fuel last year at a great loss to themselves could not be expected to be happy to do the same thing again this year. He added that mild winters the past few winters has kept the problem from becoming any more severe than it already is. "If we were to have a winter that was 10 per cent colder than normal, the supply problems would be severe," he admonished.

U. S. Imports Rise

The American Petroleum Institute has reported that imports of crude oil and petroleum products totaled 882,100 bbl for the week ended May 10 and 932,300 for the four weeks preceding that date. Imports at the end of May 3 totaled 985,300 bbl per day.

Week ended	Crude oil	Residual oil	Others	Total
	(Figs. in bbl per day)			
April 19	619,900	346,900	13,600	980,400
April 26	536,900	306,400	38,200	881,500
May 3	574,900	357,500	52,900	985,300
May 10	576,100	.....	17,700	882,100
Four weeks average	576,600	324,800	30,600	932,300

Oil, Gas Symposium Held

A Symposium on Oil and Gas sponsored by the School of Law, University of Kansas City was held in Kansas City, Missouri, recently. Oil men, lawyers, and other interested persons heard discussions of depletion tax allowances and problems of the oil industry. The program was arranged by Dr. Marlin M. Volz, dean of the school of law, and Clarel Mapes, general secretary of the Mid-Continent Oil and Gas Association, Tulsa, Oklahoma.

Bermudez Urges Solidarity Of Western Hemisphere Oil

Antonio J. Bermudez, director general of Mexico's Petroleos Mexicanos (Pemex) headed by a Mexican delegation to the 2-day spring meeting of the Interstate Oil Compact Commission in Phoenix, Arizona, recently. Bermudez, speaking before the group, called for solidarity of oil interests in the Western Hemisphere, and although he did not commit his delegation to positive alignment with the Compact, he stressed a deep interest in Commission work. He added that direct alignment of Mexico with the Compact as an official observer would have to be handled through his country's foreign office.

Bermudez told Compact members that Mexico had some oil and gas reserves partly in Mexico and partly in the U. S., and added, "I agree to apply to those wells on the Mexican side the same conservation principles which you establish on this side."

Also under discussion at the Compact meeting were public lands in Arizona and other Rocky Mountain states, and several amendments to the 1946 Mineral Leasing Law were urged in a resolution presented by a committee on public lands.

The Four Corners region, where Arizona, New Mexico, Colorado, and Utah come together may sometime prove to be the nation's most important reserves of natural gas and may as well develop significant production of oil, it was brought out at a symposium held on the geology of the region. (The Four Corners region was covered in the May issue of *The Petroleum Engineer.)*

American Cyanamid Awards Seventeen Fellowships

American Cyanamid Company's program of grants and fellowships to universities this year included 17 graduate fellowship awards in chemistry and chemical engineering, it was announced by the company. The fellowships were awarded to graduate students in their final pro-doctoral year of study and carry a stipend of $1500 plus full tuition and incidental laboratory fees. They also include $300 for unrestricted use by the department of chemistry or chemical engineering of the student's university.

Oklahoma Unit Law Upheld

The Supreme Court has upheld the state of Oklahoma's law requiring unit operation of oil fields under certain conditions. Action of the Supreme Court left no doubt, attorneys reported, that the state legislatures have adequate power to regulate oil and gas production to promote conservation.

The Oklahoma law was enacted in 1945 and revised in 1951, and was the first comprehensive law compelling unit operation of wells in a common source of supply, under prescribed conditions.

The case involved was that of the West Cement Madrano field in Caddo County. This was the first unit operation ordered by the Oklahoma Corporation Commission. The field was estimated to contain 98,000,000 bbl of oil in place, of which 24,000,000 would be recovered by ordinary competitive production and 48,000,000 bbl by unit operation and reservoir pressure maintenance by reinjection of gas. The great majority of operators in the field approved the plan but it was protested by Palmer Oil Corporation, and a large group of royalty owners.

Steel Allotments Dip In Third Quarter

The petroleum industry has been allotted 262,187 tons of steel casings and tubing in the third quarter, according to figures released by Bruce K. Brown, Deputy Petroleum Administrator. This was about 60 per cent of what the 1532 oil and gas operators represented needed, Brown reported, adding he hoped the 40 per cent deficit would be made up "through supplementary allotments and allotments of some 50,000 to 60,000 tons of conversion steel later."

Another 3289 tons have been allocated to 16 operators for the drilling of brine and sulfur wells and other miscellaneous purposes, Brown stated. Until the strike, Brown reported, steel was reported in plentiful supply but such is not the case.

Shell Oil Company's Signal Hill field discovery well brought in on June 25, 1921, was dedicated by the Petroleum Production Pioneers when a monument was unveiled at Alamitos No. 1, recently. Taking part in the recent public ceremony at Signal Hill were: W. F. Sharp, W. I. Parker, C. H. Cupernell, S. F. Bowlby, vice president, Shell Oil; D. W. and Mrs. Thornburg, J .W. Elder, and M. B. Schumacher. Sharp, Parker, Cupernell, Elder, and Schumacher were members of the crew that worked on Alamitos No. 1 in 1921. Thornburg was a member of the Shell geological party that surveyed the Long Beach area in 1920.

J. Ed Warren

Warren to Head PAD

J. Ed Warren, president of Carl B. King Drilling Company, and a partner in King, Warren, and Dye, has been named to head the Petroleum Administration for Defense upon retirement of Bruce K. Brown.

Brown winds up a year as deputy administrator without compensation, to return to his job as president of the Pan-Am Southern Corporation, New Orleans, Louisiana. Brown was vice president of Standard Oil of Indiana until 1949, when his job as president of the producing subsidiary, Pan-Am, claimed all his time.

Warren was with the U. S. Bureau of Mines in 1925 and 26 and late that year joined Marland Oil Company. The same year he joined Continental Oil Company and in 1934 joined Carl B. King Drilling as president. His offices are in Midland, Texas.

Saudi Arabia Reported Asking for Royalty Raise

A spokesman for Arabian-American Oil Company has reported that Saudi Arabia's head, King Ibn Saud, is asking for a sharp increase in the present 50-50 share on the company's net profits. Extent of the demands has not been reported, but the spokesman reported that negotiations had been going on since January.

The 50-50 profit sharing plan was set in December of 1940, and was followed by similar revisions throughout the Middle East countries and oil companies operating in them.

Confirmation of the talks between the Arabian government and Aramco has not been forthcoming from the New York office of the company. A statement issued from the office stated that intermittent discussions with Saudi Arabian officials were being held dealing with a variety of things but upward revision of the royalty rate was not involved.

An undisclosed source who was reported to have discussed the question with Ibn Saud and other officials of the country, said their demands would include a 50-50 share of Aramco royalties before deduction of taxes for the United States. This, it was reported, would boost the king's annual oil revenue from its present estimated $150,000,000 to about $200,000,000 a year.

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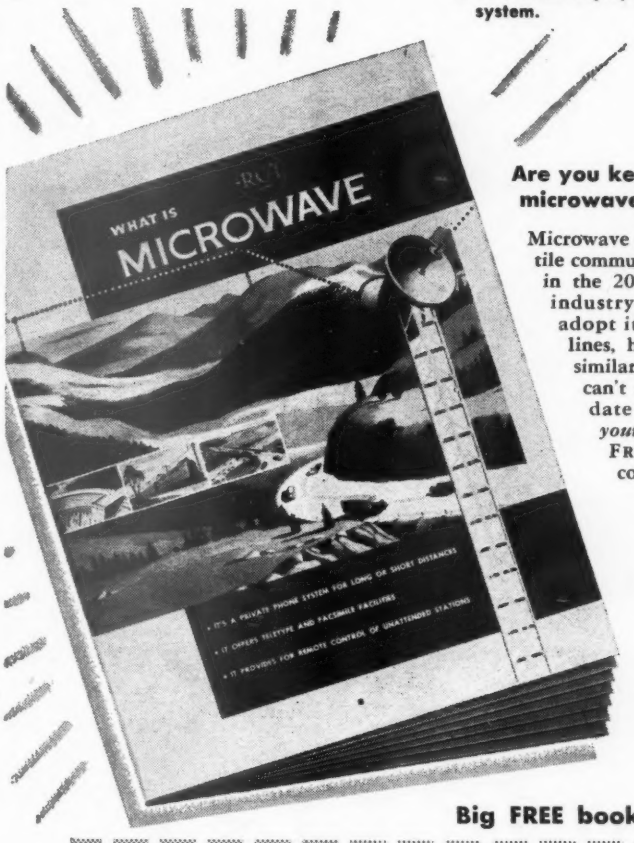

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This engine was purchased new and placed in operation in June, 1948, and has operated approximately 7,400 hours. It has had top quality maintenance, is in good condition, and is available, because the drive it served has been electrified.

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Petro-Chemical Plant desires young Chemical Engineer interested in development program of water treatment and industrial waste disposal including boiler plant, cooling water, biological digestion pilot plants for effluent. Salary commensurate with background. Send outline of training, education, and personal data to Personnel Superintendent, Celanese Corporation of America, Box 148, Bishop, Texas.

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HOUSTON, TEXAS

WSB Limits Oil Workers Wage Increase to 15 Cents

Decision of the Wage Stabilization Board to set a 15 cents an hour limit on oil industry wage raises has sent striking workers back on the job throughout the nation. The Oil Workers International Union (CIO) announced its reluctance to accept the increase, but it was five cents an hour more than allowed under the WSB regulations.

The Board also approved an increase in shift premiums from 4 and 6 cents to 6 and 12 cents per hour. Many companies had offered as much as 15 cents in the beginning but were refused. The Union's refusal to accept these raises made it evident that it hoped to establish industry-wide bargaining. Possibly the worst setback for CIO oil workers' chief, "Jack" Knight was when the WSB refused to proceed with panel hearings on national basis and returned all disputes for local level bargaining, when companies refused to send representatives to the board hearings.

Fellowship Granted

Four oil companies have announced graduate fellowships to the University of Oklahoma. They are Shell Oil Company and affiliate Shell companies, Stanolind Oil and Gas Company, Humble Oil and Refining Company, Sinclair Refining Company.

PAD Names New Assistant Director of Transportation

Perry A. Peterson has been named assistant director of the supply and transportation division of the Petroleum Administration for Defense.

With PAD since February, 1951, Peterson formerly was assistant to the division director, Charles E. Spahr.

Born in Rapid River, Michigan, March 17, 1916, he took his BA at Lawrence College, his MBA at Harvard Business School and then joined the Allied Oil Company, Cleveland, as a management assistant. After a little more than a year with the company he went to Washington in 1941 as an assistant business specialist with the Office of Price Administration, but after Pearl Harbor joined the Navy.

Separated from service in 1946, he returned to the Allied Oil Company, where he was successively management assistant, assistant manager of sales, and finally manager of sales. He held the latter post at the time he joined the PAD staff.

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Send for list. Can offer Williston Basin minerals for $10 per acre with $1.00 annual rentals. Can sell in minimum tracts of 40 acres. Solicit sales only to those connected with oil or royalty business. References exchanged. Write or call Milburn & Milburn, Sewell Building, Telephone 6-6439, Odessa, Texas.

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Every Marley fan, whether it be a 72-inch fan or a 264-inch giant, is the product of thousands of hours of Marley research and development.

On the drawing board it is checked and rechecked for engineering exactness. Then begins the long process of testing—first as a scale model, then on to a production model and hundreds of hours in Marley's outdoor laboratory. Here engineering specialists, assisted by finest electronic analysis equipment, check and record its performance under actual operating conditions.

Once approved for production the vigil does not cease. Every step from pattern making to field installation is rigidly controlled and inspected. All machine processes in the Marley fan department are inspected by trained experts and any error means rejection. Final balancing that means smoothness of operation is done by men with years of training and experience.

This exacting method of development and production is assurance that the fan installed on any Marley cooling tower will do the exact job it is designed for. Actual tests of every kind over long periods have proved it.

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MARLEY

The Marley Company, Inc.

Kansas City 5, Missouri

R. G. Follis

J. C. Donnell

Follis, Donnell Attend API Production Meet

R. G. Follis, chairman of the board of Standard Oil Company of California, and J. C. Donnell II, president of the Ohio Oil Company, were present at a gathering of more than 1000 West Coast oil men at a two-day meeting in Los Angeles, California, May 15 and 16, 1952.

The conclave, at the Biltmore Hotel, was the twenty-fifth anniversary meeting of the Pacific Coast District, American Petroleum Institute's Division of Production.

Follis addressed the group Thursday afternoon, May 15. His speech was entitled "Foreign Oil—A Challenge to American Enterprise."

Donnell is vice president for production of the American Petroleum Institute.

White Heads Oil, Gas Meet At Polytechnic Institute

John R. White, executive vice president of Imperial Oil Ltd., Toronto, Canada, headed a special panel meeting at Rensselaer Polytechnic Institute recently, to discuss "Contribution of the Oil Industry to Society." The panel was one of three that functioned during the two-day symposium on the oil industry. Another panel was headed by Earl Newsom, senior partner in the firm of Earl Newsom and Company, New York, which lead discussion on "Development of the Oil Industry."

Cities Service Moves Its Fort Worth Office

D. A. Dechman, production manager for Cities Service Oil Company, has announced the company's Fort Worth, Texas offices have been moved to the Fort Worth National Bank Building. Telephone number, FOrtune 0441.

Engineers Will Attend Third UPADI Congress

Engineers Joint Council have announced its formal acceptance of an invitation to send representatives to the Third UPADI Congress in New Orleans, Louisiana, August 25-30, 1952. The delegation will be made up of representatives of each of the constituent societies. UPADI is the Pan-American Union of Engineering Societies. It encompasses the engineering societies of both North and South America.

Texas Oil Allowables Drop Lowest Since March '51

Texas has cut its daily oil allowables for June to 2,847,875 bbl per day, the lowest since March of last year. The Texas Railroad Commission cut 113,244 bbl off the state's daily crude oil output this month. This figure compares with 2,800,742 bbl daily for March, 1951.

A 19-day producing schedule has been ordered for this month, comparing with May's 21 days for the state generally and 19 for East Texas.

Most oil company representatives had urged bigger cuts in daily production at the Corporation hearing. They gave as reasons the effects of the refinery strike on storage facilities and already heavy stocks of crude oil.

November Oil Output Up

In November, world crude production increased by 32,000 bbl daily to a daily average of 11,959,000 bbl. The slight advance occurred despite the fact that production in the United States declined by 2 per cent. Production also decreased in Canada, Venezuela, and Kuwait by 16, 2, and 4 per cent respectively. Saudi Arabia had a record production of 897,000 bbl daily, an increase of 6 per cent over October. Production in Iran rose to an estimated daily average of 84,000 bbl due to the fact that crude distillation Unit No. 70 at the Abadan refinery was put into operation by the National Iranian Oil Company early in November. Only the small Kermanshah refinery was operating in October.

Imports of crude into Western Europe reached a record daily rate of 1,316,000 bbl, an increase of 2 per cent over October. Principal increases occurred in France, a record 412,000 bbl daily (388,000 in October); United Kingdom, a record 491,000 bbl (454,000); and Western Germany, 83,000 (45,000). The French and United Kingdom increases reflect refinery expansions completed last fall.

PAD Issues Export Figures

The Petroleum Administration for Defense has issued the following summary of the U. S. exports of major petroleum products:

Week ending	Avgas*	Motor Gasoline	Kerosine	Distillate	Residual	Total
March 28	30.2	1.1	44.0	53.5	35.3	164.1
April 4	37.5	25.7	0.1	46.2	58.5	168.0
April 11	27.1	29.6	17.1	88.9	77.0	239.7
April 18	56.8	14.9	30.9	101.6	82.3	286.5

*Avgas is partly estimated and includes all methods of shipment.

Tri-City Desk and Derrick Club Members tour Delhi field. Members of the Jackson, Mississippi, Shreveport, Louisiana, and Monroe, Louisiana clubs were guests of Sun Oil Company recently, who took them through the Delhi field, the gas plant, and the Mid-Valley pumping station for an all-day field trip. Delhi field is in Richland and Franklin Parishes.

PERSONALS

J. Howard Marshall has been named director of Signal Oil and Gas Company. He will be stationed in the company's division office at Fort Worth, Texas, in charge of exploration in the Mid-Continent area, under the direction of D. H. Lycan, director and vice president in charge of exploration for the company. Marshall brings to Signal a broad and extensive experience in all phases of the oil industry, having been president of Ashland Oil and Refining Company.

Walter R. Reitz, Oil City, Pennsylvania, has been elected president of the Quaker State Oil Refining Corporation. He succeeds **Samuel Messer,** who has been president since 1947. **S. O. Zoontz** was elected a vice president.

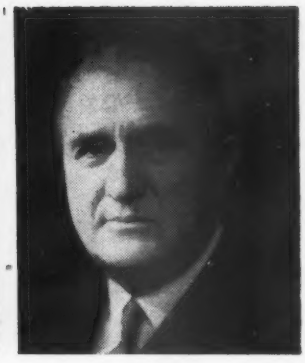
Henderson Supplee, Jr., has been elected president of The Atlantic Refining Company succeeding **Robert H. Colley.** This action was taken by the board of directors at a meeting following the annual stockholders' meeting. Colley, who has been associated with Atlantic for 33 years, was elected chairman of the board. As president, Supplee becomes chief executive officer of Atlantic. Supplee was educated at The Episcopal Academy, Princeton University (A.B. 1927), and the University of Pennsylvania School of Finance. He came to Atlantic in 1947. In 1948 he was elected to the board of Atlantic and in May 1949, was named executive vice president.

W. F. Stroud has been named vice president of Atlantic, as well as general manager of manufacturing. In this position he will be in charge of all manufacturing activities of the company and responsible for the purchase of crude oil required by the refineries to supplement Atlantic's own production.

Stroud joined Atlantic in 1916. During his service he has held the positions of superintendent of the gas department and also of the lubricating department in the Philadelphia refinery. He was graduated from New York University in 1916. In his new responsibility, Stroud succeeds **E. J. Henry,** who, after 47 years of service with Atlantic, has withdrawn from active functional management in the company. Henry remains as a director of Atlantic.

H. A. W. Kidd

Harry T. Klein



J. S. Leach

H. A. W. Kidd has been named assistant to the director of the Soconv-Vacuum laboratories at 26 Broadway, New York, it was announced by J. L. Latimer, president of Magnolia Petroleum Company, an affiliate of Socony Vacuum. Kidd has been assistant to the director of Magnolia's Field Research Laboratories in Dallas, Texas, for the past eight years. Before that time he was a chemical engineer there, and before coming with Magnolia spent 15 years in research, technical services, and production in the chemical industry. Kidd was graduated from Oregon State College in Chemistry and in 1939 and 1940 did graduate work at Oregon State and the University of Texas.

Kidd will be succeeded at Magnolia's Field Research Laboratories by **Eugene Stanton Wilhelm,** who was employed there nearly five years ago as a physicist. Wilhelm was graduated from the University of Texas.

John M. Haydon has been named to public relations manager of the Bardahl Oil Company, Seattle, Washington. The public relations and advertising department has just been set up. Announcement was made by Ole Bardahl, president of Bardahl Oil.

Sybrand J. Veenstra has been named vice president of Asiatic Petroleum Corporation. Veenstra joined Bataafsche Petroleum Maatschappij at The Hague in 1928, having graduated from the University of Delft, Holland. From 1930 to 1939 he held various jobs in The Hague. In 1939 he left The Netherlands East Indies to join the New York staff of Asiatic Petroleum Corporation.

Colonel Harry T. Klein has been elected chairman of the executive committee, The Texas Company, a newly created position. Executive vice president, **J. Sayles Leach,** was elected president of the company to succeed Colonel Klein.

Colonel Klein entered the service of The Texas Company in 1921 as assistant general counsel and was appointed general counsel in 1925. In 1933, he was elected vice president and general counsel, and a director of The Texas Company. He was elected president of the company in 1944 and served in that capacity up to the present time.

J. Sayles Leach entered the service of Texaco in 1916 as a bookkeeper in the Dallas sales office. By 1925, he had advanced to the post of superintendent of sales of the Dallas district, and in 1927, he became assistant manager of sales for the Southern Territory, with headquarters in Houston. In 1950, he was named executive vice president, with headquarters in New York. Both Klein and Leach will continue to serve as directors of the company.

Reginald W. Ragland and **Stender Sweeney** were elected vice presidents of Richfield Oil Corporation at a meeting of the board of directors recently. Ragland, assistant to the president, joined the Richfield organization in 1937. Prior to that time he was assistant general counsel with Consolidated Oil Corporation and Sinclair Oil Corporation in New York. He is a graduate of the University of Missouri and the University of Chicago Law School.

Sweeney, personnel director for Richfield, has been associated with the company continuously since 1928, serving as petroleum engineer, drilling foreman, and division superintendent of production operations until 1941. At that time he was appointed personnel director in which capacity he has served to the present.

Sam Rhoades of Fordee Rhoades Oil Company, has been elected president of the Petroleum Club of Tulsa. He succeeds Earl Sneed, Sneed Oil Company. Other officers include: **Robert Wood,** Broswood Oil Company, vice president; **James McWilliams,** Deep Rock Oil Corporation, secretary, and **Frank Frawley,** Frawley Drilling, treasurer.

H. Supplee, Jr.

W. F. Stroud

S. J. Veenstra

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in the Front Rank of Industry
ON ALL 5 COUNTS

OPEN SPACE • STRENGTH
LONG LIFE • CLEANNESS
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Blaw-Knox Steel Grating is electroforged into rigid, one-piece panels, using twisted cross bars for firm footing. Bring your open steel flooring problems to Blaw-Knox for expert help. Bulletin 2365 sent on request.

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An EASIER WAY
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***Use* DURA HOOKS**

Rugged, flexible, hand-tools that "work around corners" for removing old packing from stuffing boxes. They SAVE TIME . . . put an end to fussing and cussing . . . improves your manpower efficiency. WRITE FOR DURA HOOK Bulletin DHPE covering SIZES and PRICES.

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The PERFECT SEAL

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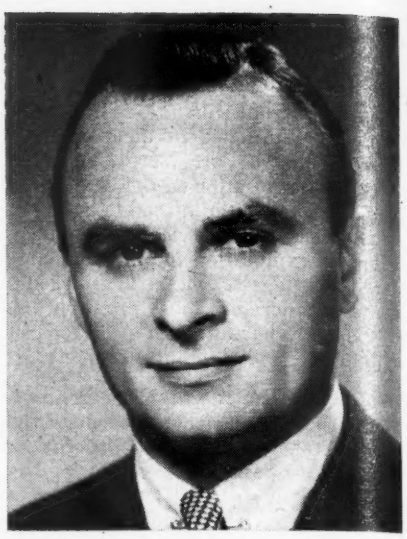


Disque D. Deane

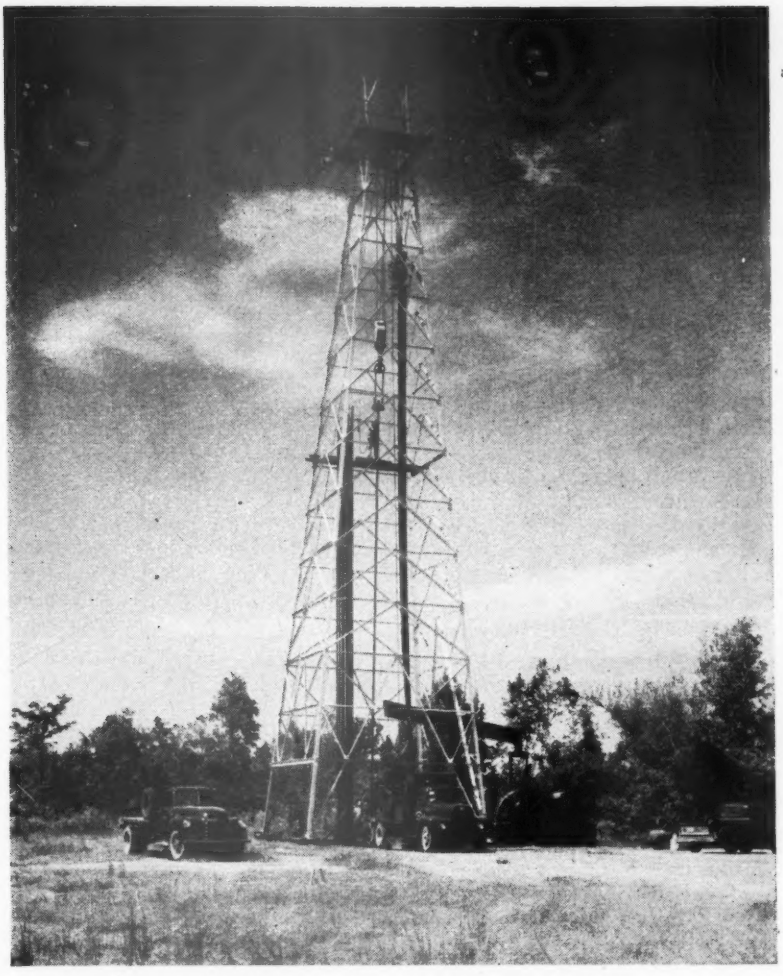
Disque Deane of New York City and **Colin Campbell,** Toronto, have been elected directors of a new company, Canadian Decalta Gas and Oils, Limited, formed from the former company, Decalta Oils, Ltd. Deane, associated with Union Securities Corporation of New York, was also elected chairman of the new company's finance committee. It was also announced that Meyer Achtschin of Dallas, Texas, has been engaged as consultant for Decalta Gas and Oils, Ltd.

H. Curtis Flowers, of Montgomery, Alabama, has been named district representative for the Oil Industry Information Committee, with offices in Jackson, Mississippi. The opening of the Jackson office marks the 13th district OIIC office established since the inception of the national oil industry public relations program nearly five years ago. As a staff representative, Flowers will work principally with OIIC committees covering Alabama and Mississippi.

Flowers for the last 15 months has served as secretary to the Alabama Petroleum Industries Committee. He was graduated from Campbell Institute, Dothan, Alabama.

D. C. (Pat) Endom, manager of material accounting for Sun Oil Company at Dallas, Texas, has been appointed office manager for Sun at Calgary, Alberta, Canada. Endom was graduated cum laude from St. Edward's University, Austin, Texas, with a degree in business administration and has been with Sun during the ensuing 18 years.

J. R. Evans, an executive of Stanolind Oil and Gas Company, was named director of the First National Bank of Fort Worth. Manager and attorney-in-fact of the North Texas-New Mexico Division of the Stanolind Oil and Gas since 1948, Evans was elected a director of that organization in January, 1952. He has been with the company since it was formed in 1930. Evans attended the Missouri School of Mines and was graduated from the Colorado School of Mines.



Longer Life For Sucker Rods and Tubing with *COREXIT*

Corexit brings new profits from pumping wells by checking sucker rod and tubing failures due to corrosion. This compound prevents failures that cost you in lost pumping time and production man - hours, as well as the cost of replacing or repairing corrosion - damaged equipment.

Forms Protective Coating

After Corexit is injected or batch-dumped into the well annulus, it gradually builds up a protective coating inside the tubing and on the sucker rods to prevent new corrosion. Where corrosion has already started, tests show that Corexit seeks out pits and other corroded spots and coats them first, to check further corrosion.

Prevents Hydrogen Embrittlement

Many sucker rod failures can be traced to hydrogen embrittlement. On old sucker rods, Corexit coats the corroded spots, preventing the entrance of additional atomic hydrogen. On new sucker rods, Corexit combats hydrogen embrittlement.

Try Corexit for six months, and note the substantial savings. Write for information.

HUMBLE

HUMBLE OIL & REFINING CO.

P. O. BOX 2180 HOUSTON, TEXAS

▸ **Alfred M. Houghton** has relinquished his duties as patent counsel, Gulf Oil Corporation, but will continue in the employ of the Gulf Companies as consulting patent counsel. **Horace B. Cooke** will succeed Houghton as patent counsel, and **Gordon A. Kessler** has been appointed assistant patent counsel. Houghton has been patent counsel for the Gulf Companies since 1914, originally as an attorney in private practice in Washington, D. C., and since 1944 he has been head of the patent department of the corporation.

▸ **W. E. Church,** telephone superintendent, Shell Oil Company, Los Angeles, was elected vice president of the Petroleum Industry Electrical Association (PIEA) and the Petroleum Electric Supply Association at the 24th annual conference held in Tulsa, Oklahoma. More than 700 attended the 4-day program of study and discussion of the latest applications of electronics and electricity to pipe lines and other phases of the oil and gas industry.

Other officers elected were **H. G. Pegues,** United Gas and Pipe Line Company, Shreveport, Louisiana, president, and **E. E. Comstock,** Phillips Petroleum Company, Bartlesville, Oklahoma, secretary-treasurer.

▸ **R. C. Jopling,** vice president, Phillips Petroleum Company, will hereafter devote his entire time to representing the company in Washington, D. C. His previous additional duties as head of the advertising department are being assumed by **F. L. Rice,** who continues as manager of that department. **O. E. Bettis** will continue as advertising manager.

Myron O. Johnson has been named manager of the newly created coordination and supply department, which will be responsible for the coordination and product exchange activities formerly handled by the supply and transportation department. In addition, the new department will handle the refined products and liquefied petroleum gas purchases formerly handled by the sales department. **John L. Kyser,** coordinator, is assistant manager of the new department.

E. H. Lyon has been named assistant sales manager, and will assist the sales manager in the overall operation of the department. **John Getgood,** formerly assistant division manager in the Chicago division, has been promoted to regional manager, replacing Lyon, with headquarters in Bartlesville, Oklahoma.

Third Domino Tournament of the Petroleum Club of Los Angeles was held recently. Participating in the final match were: Basil Kantzer, Union Oil of California, runner-up; A. C. "Cy" Rubel, Union Oil, Graydon Oliver, consultant, substituting for W. H. "Bill" Geis, consultant, the winning team, and Sam Grinsfelder, Union Oil.

▸ **Richard F. Sheehan** has been appointed supervisor of advertising for the Oil Industry Information Committee. He will report for duty on May 8, and will make his headquarters at the OIIC's national offices in New York. Sheehan is leaving the G. M. Basford Company in New York to accept his new position.

Sheehan was educated at Harrisburg, (Pennsylvania) Academy, Trinity University in Dublin, Ireland, and Pace Institute, New York.

▸ **Gilbert C. Pearson** has been named assistant treasurer of Pan-Am Southern Corporation. Credit manager of Pan-Am for several years Pearson was the only new officer elected in the company by the annual election meeting. Directors re-elected include **Roy J. Diwoky,** executive vice president; **Thomas W. Hughes,** financial vice president; **Robert L. Aycock,** vice president; **Richard T. Colquette,** vice president; **Milton C. Hoffman,** vice president; **Harry S. Read,** vice president; **Sam H. Casey, D. P. Hamilton,** and **Frank R. Lutenbacher,** directors.

Officers also include **Albin J. Ganier,** comptroller, **Asa L. Reid,** treasurer, **Preston L. Schowalter,** secretary, **G. A. Thornbury,** and **George P. Brown,** assistant secretaries.

Pearson, who was elected to a newly created position, has been with Pan-Am since 1925.

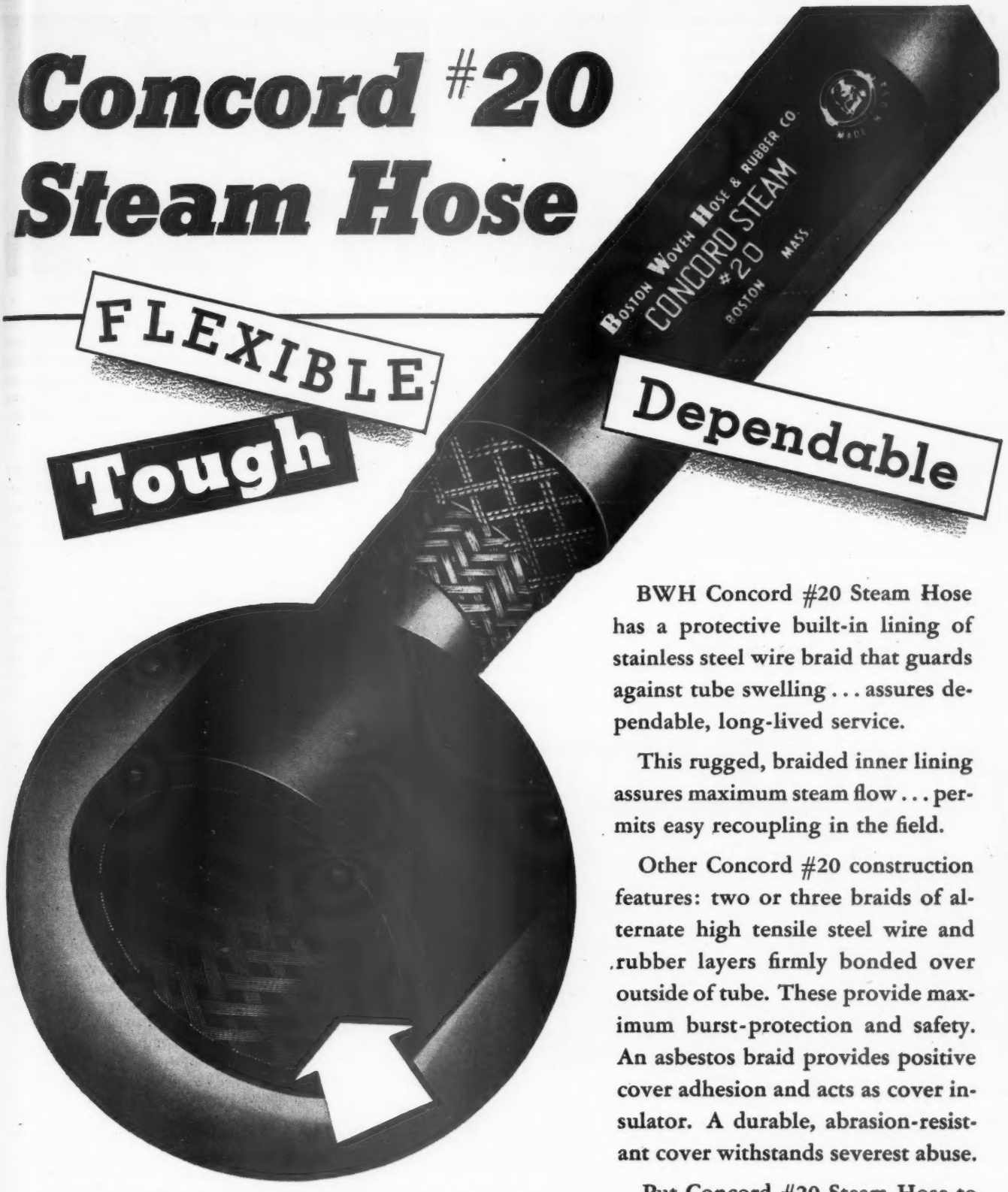
Visiting a Houston Nomads' Meeting recently were: C. L. Smith, PETCO, Maracaibo, Venezuela; Jean P. Rochet, SEREPT, Tunis, Tunisia; George Cormack, Shell Oil Company, Calgary, Alberta, Canada; A. J. Dodini, Bahrein Petroleum Company, Ltd., Bahrein Islands; and C. F. Watts, Shell Oil, Calgary, Alberta, Canada. At right is Jack Kinley, M. M. Kinley Company, guest speaker.

Concord #20 Steam Hose

FLEXIBLE

Tough

Dependable



BWH Concord #20 Steam Hose has a protective built-in lining of stainless steel wire braid that guards against tube swelling . . . assures dependable, long-lived service.

This rugged, braided inner lining assures maximum steam flow . . . permits easy recoupling in the field.

Other Concord #20 construction features: two or three braids of alternate high tensile steel wire and rubber layers firmly bonded over outside of tube. These provide maximum burst-protection and safety. An asbestos braid provides positive cover adhesion and acts as cover insulator. A durable, abrasion-resistant cover withstands severest abuse.

Put Concord #20 Steam Hose to work for *you — now!*

Illustration shows how special built-in lining of stainless steel inner wire braid assures long life under the most severe operating conditions.

Pat. applied for

Another Quality Product of

BOSTON WOVEN HOSE & RUBBER COMPANY

Distributors in all Principal Cities

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BWH

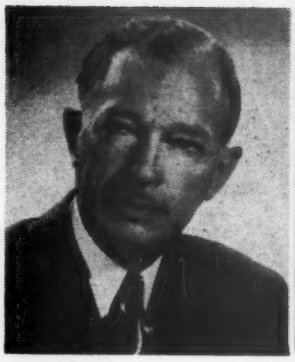
DEPENDABLE RUGGEDNESS

Eugene McElvaney, senior vice president of the First National Bank in Dallas, has been named to the board of Texas Pacific Coal and Oil Company. McElvaney is treasurer of Texas Mid-Continent Oil and Gas Association, and a director of the Tennessee Gas Transmission Company and Tennessee Production Company.

His election was announced with the re-election of the other members of the board, which renamed present officers of the company.

J. A. McQuilkin has been elected a director of the Standard-Vacuum Oil Company, the company has announced. A petroleum marketer in Southeast Asia for a quarter-century, he has been serving since 1950 at Stanvac's New York office as deputy manager and later manager for the company's Southeast Asia organization. McQuilkin entered the oil business in 1926 and was assigned a year later as a salesman in Malaya. Appointed territory manager for Thailand in 1936, he was promoted to manager for the Malaya-Thailand division in 1940 with headquarters at Singapore. He was acting division manager there for a short time prior to World War II. He was graduated from Princeton University.

J. R. Woodward has been appointed to the position of credit manager—retail in the general credit department of the Gulf Oil Corporation. Woodward joined Gulf in 1927 as a bookkeeper in the accounting department of the Pittsburgh division office. In 1950 he was made section head—system and office equipment and has served in that capacity until his recent appointment.



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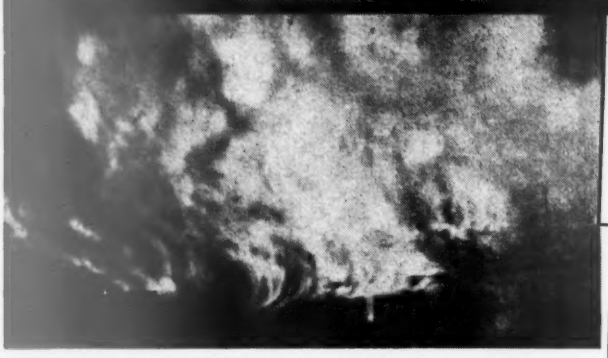
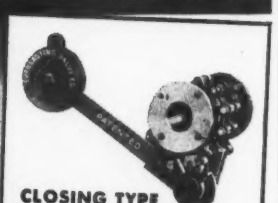
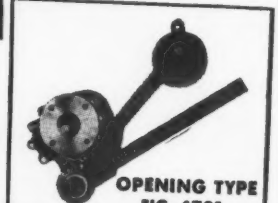
STOP WORRYING ABOUT FIRE!





CLOSING TYPE
FIG. 4831

For emergency shut-off of inflammable liquids or to divert water or steam to fire mains.



OPENING TYPE
FIG. 4721

For diversion of water to sprinkler deluge or water curtain system or to divert inflammable liquids to a point of safety.

Get EVERLASTING VALVE protection

You are SURE of instant, unfailing safeguards when you install EVERLASTING VALVES operated with Pendulum Stop on your fire protection system.

When the weighted pendulum of this valve is released, there's not a moment of delay — the valve action is immediate and positive...the flow is full and unimpeded...there's no danger of sticking, binding or wedging.

These valves are made in all sizes from 1 in. to 8 in. in metals to meet service conditions, and may be arranged for thermostatic, electrical or manual control from any location.

Write for Bulletin E-52C describing these valves in detail.

EVERLASTING VALVE COMPANY, 49 FISK STREET, JERSEY CITY 5, N. J.

Everlasting Valves FOR EVERLASTING PROTECTION

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DEATHS

C. O. G. Miller

Christian Otto Gerberding Miller, founder and chairman of the board of directors of Pacific Lighting Corporation, passed away in San Francisco recently, bringing to an end a career that had been devoted to the development of the gas industry in California over a period of nearly 70 years. He was recognized as the state's greatest public utility organizer and as one of its most enlightened and generous business and cultural leaders. He was 86 years of age on his last birthday, October 1, 1951.

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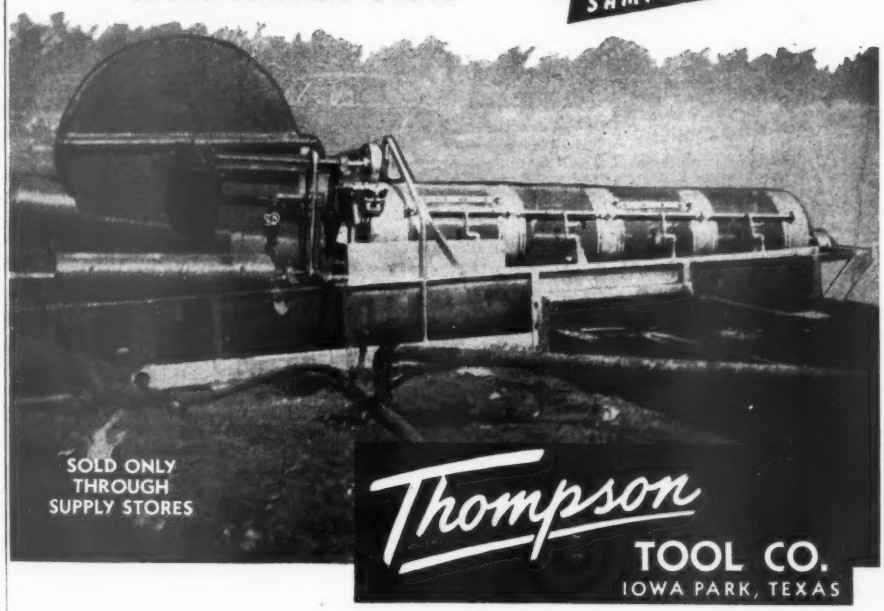
in OIL FIELDS!

SHALE SEPARATOR & SAMPLE MACHINE

Thompson does a double duty job and does it better: (1) by removing destructive shale and abrasives from your drilling mud, it saves you money because unnecessary wear and tear on costly drilling equipment is reduced to a minimum, and (2) the Sample Machine (standard equipment) gives an accurate analysis of the progress of the well by collecting foot-by-foot cuttings. Thompson Separators are self-motivated, activated by the mud flow. Make Thompson a part of your standard drilling equipment.

★ PROVEN PERFORMANCE
★ ECONOMICAL OPERATION
★ SAVES DRILLING COSTS



Thompson TOOL CO.
IOWA PARK, TEXAS

Eugene McElvaney, senior vice president of the First National Bank in Dallas, has been named to the board of Texas Pacific Coal and Oil Company. McElvaney is treasurer of Texas Mid-Continent Oil and Gas Association, and a director of the Tennessee Gas Transmission Company and Tennessee Production Company.

His election was announced with the re-election of the other members of the board, which renamed present officers of the company.

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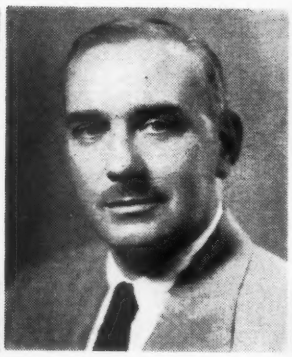

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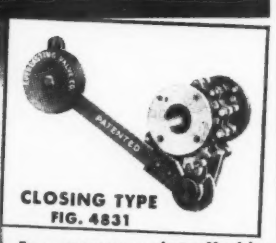

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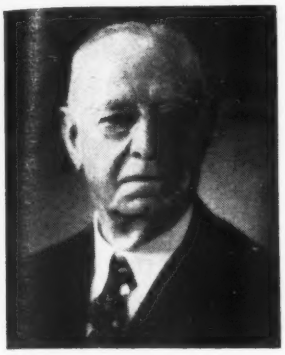

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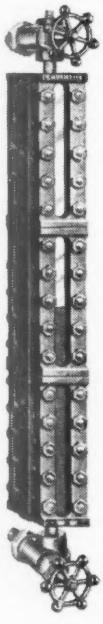
PENBERTHY Liquid Level Gages

YOU CAN *Remove and Replace Without Shutdown*

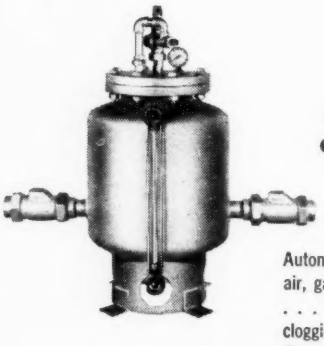
Union connections between the gage and the valves permit removal of gage for repairs without shutting down the equipment. Just close the valves, uncouple the unions and remove the gage. The convenience of this is obvious. When glasses have to be replaced or repairs made, it is not necessary to work in an awkward position or to shut down. Another advantage: a gage needing repairs can be replaced immediately by a spare and the repairs made at leisure. There are many other reasons for the superiority of Penberthy Liquid Level Gages; ask for Catalog 35.

OTHER PENBERTHY PRODUCTS



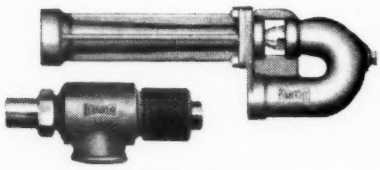
PENBERTHY TRANSPARENT GAGE

Used to observe color and density of liquids under high pressures and/or temperatures. Exceptionally sturdy construction—liquid chamber machined from solid block of metal. Ask for Catalog 35.



PENBERTHY CYCLING JET PUMPS

Automatically operated by air, gas or steam pressure . . . Will pump without clogging any liquid that will flow through pipes. Ask for Bulletin 5030.



PENBERTHY EJECTORS

A simple jet pump operated by air, water or steam. Needs no lubrication . . . will not get out of order. Made in wide variety of materials and special units developed to meet unusual conditions. Ask for Bulletin 512.

PENBERTHY EXPLOSION-PROOF SUMP PUMPS

Motor and switch totally enclosed. Underwriter approved for Class 1, Group D, and Class 2, Groups E, F and G hazardous location. Made of copper and bronze throughout. Ask for Bulletin 4929.

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PENBERTHY INJECTOR COMPANY

DIVISION OF THE BUFFALO-ECLIPSE CORPORATION

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Established 1886 — *Canadian Plant, Windsor, Ontario*

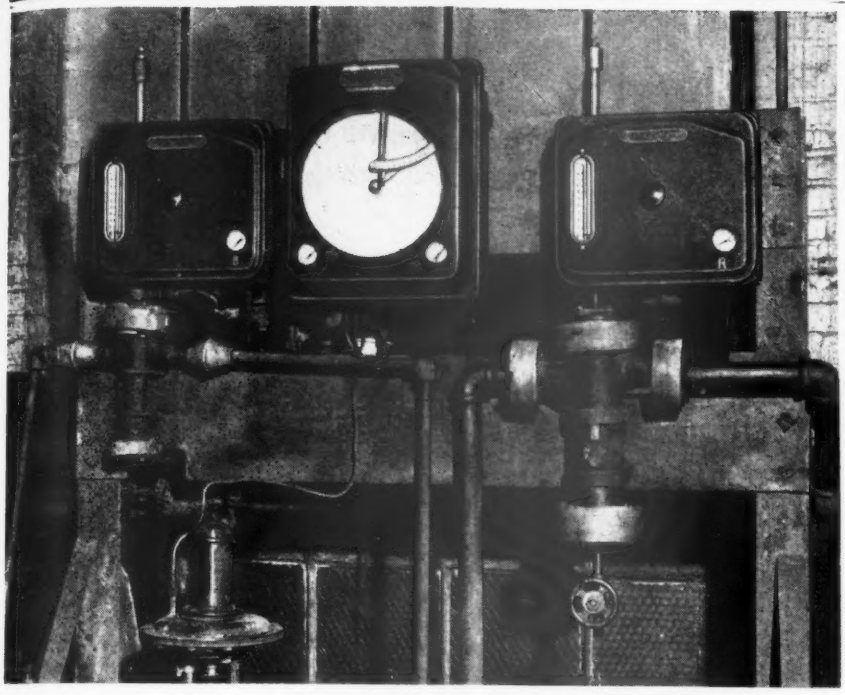


FIG. 8. Photograph showing armored Flowrator meter transmitter with ratio controller on white oil-oleum blending at Bayway, New Jersey refinery of Esso Standard Oil Company.

tried. In one Eastern refinery, successful measurement of strong acid solved a considerable operating problem—the principal pump was putting out three-quarters of claimed capacity.

By-Products

Of course, the extensive by-products operations conducted in conjunction with some refineries are complete chemical operations, and this becomes an entirely separate problem. Such problems, however, as oleum-acid oil blending for white oil refining again typify the multiple ability of the area meter to handle corrosion, suspensions (pepper sludge in the acid oil), and provide wide range proportioning as a premium. (Fig. 8)

Handling of Wax

Measurement of waxy raffinates and other streams becomes as reasonable and as successful as the handling of heavier ends from the asphalt base crudes. Solvent de-waxing with a Ratosleeve is not only desirable because of the ability of the area meter to handle wax and solvents but because of economies of floor space desirable in treating units due to the elimination of the need for metering runs for orifices. (Fig. 9)

Chilled paraffin distillate with 10 per cent wax crystals is metered successfully at a Gulf Coast refinery.

At one refinery wax sweater operation, glass tube Flowrator meters, complete with proportional reset control, are used for automatic control of heat input. This arrangement was found to be more satisfactory than the original cascade control system in which the Flowrator meter controller reset the temperature controller index.

Lube Oils

Acid refining of lube oil was actually one of the first Flowrator meter applications after the rotameter became fitted up with transmitting and control functions. Several successful installations exist, and again the ability to provide good measurement in the face of reciprocating pump delivery, high viscosity, and considerable corrosion — concluding the entire package in a flexible, wide range proportioning system— proves the versatility of the Flowrator meter. Another interesting application in the lube oil plant includes a battery of flow rate indicators for balancing flow rates to multiple lube oil filters.

One of the very popular applications of area meters in Gulf Coast refineries is on phenolic water and phenolic vapor in phenol treating of lube oils. In particular, one refinery reported that a Ratosleeve totalizer on phenol plant extract tower bottoms has permitted them finally to make the first good material balance on the unit. (Fig. 10.)

Caustic

Beginning with the continuous dilution of concentrated (72 per cent) caustic by ratioing water to hot strong caustic from the tank car permitting direct storage of 50 per cent strength, Flowrator meters are used for a variety of caustic measurement and control problems, at fixed rates or as elements in proportioning systems.

Chlorine

Chlorine is used for many refinery problems, particularly for inhibiting growths in cooling water that reduce heat transfer efficiency, and area meters have become standard for these problems. The Flowrator meter is the basis of the Fischer and Porter complete chlorinator, finding wide application in refineries. * * *

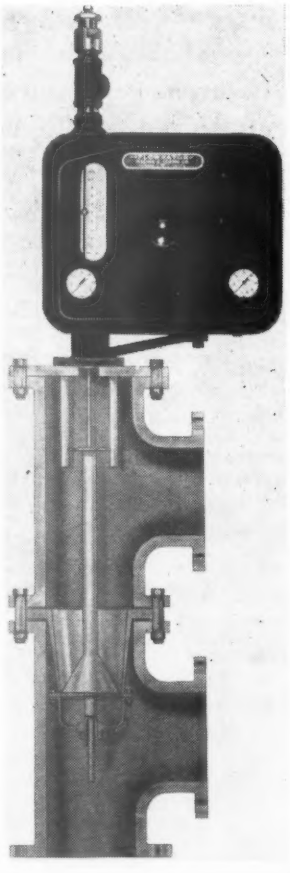
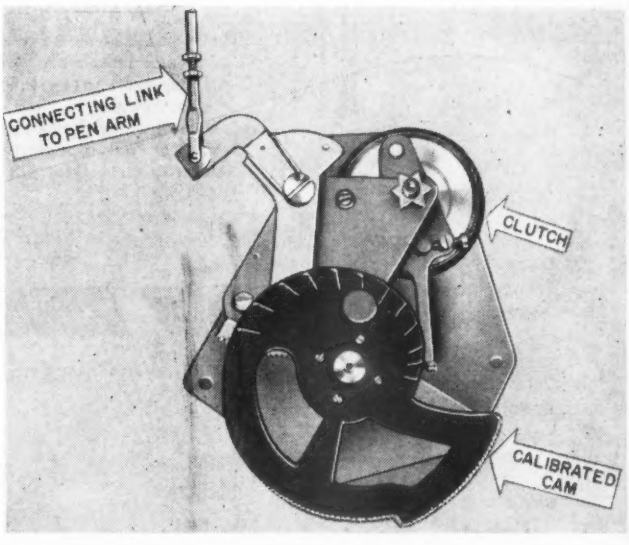
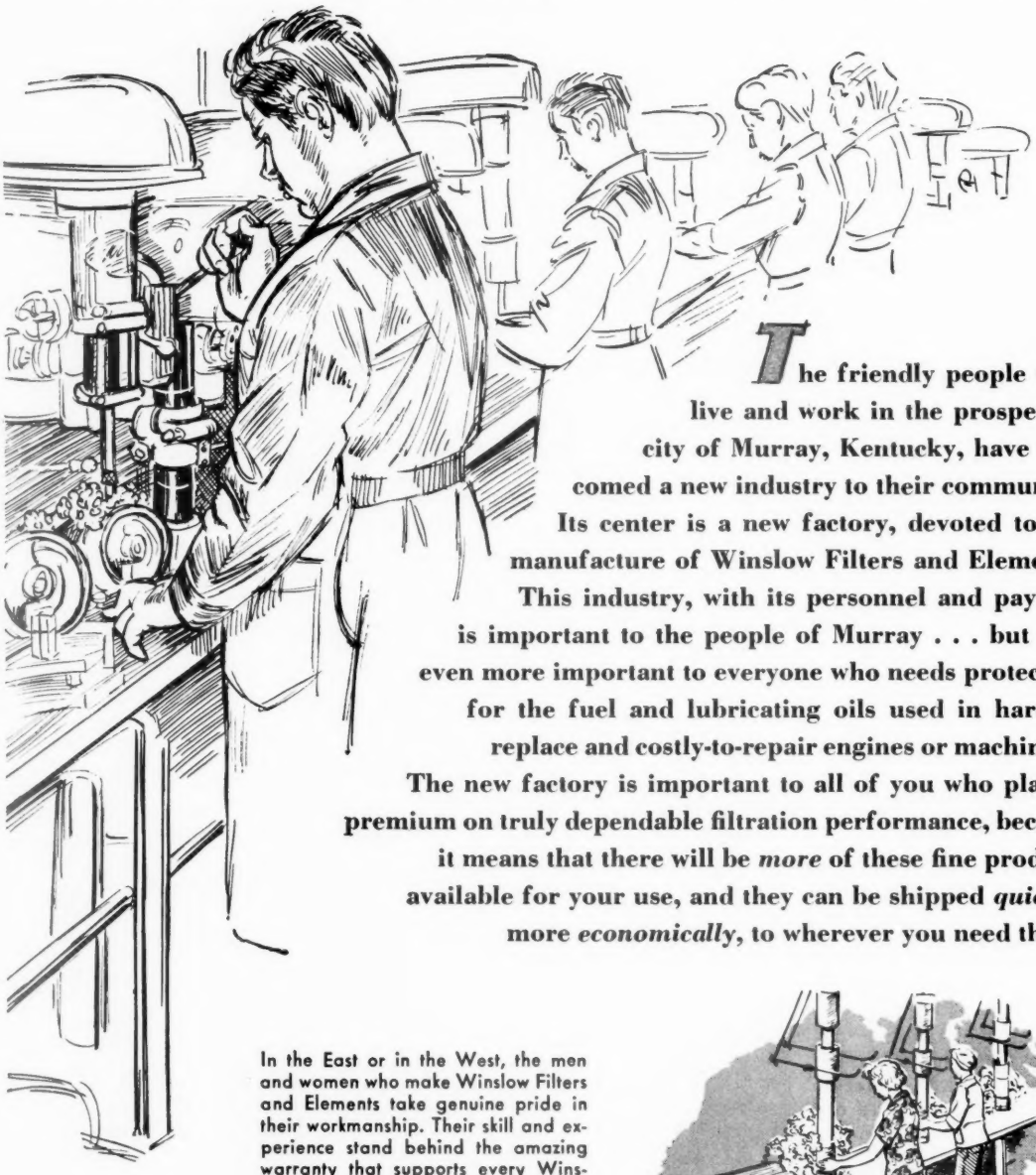


FIG. 9. Ratosleeve meter with Magnabond pneumatic transmitter. Metering elements are economically installed in standard tee fittings to provide high capacity area type meter.

FIG. 10. Flowrator meter totalizer showing large (7-in. effective cam surface) plastic cam development in polar coordinates to exact flow curve of the meter.

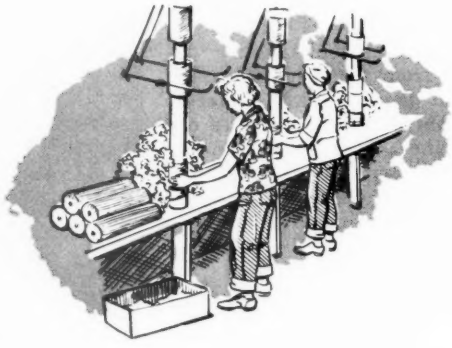


A New Winslow Factory For Faster Service



The friendly people who live and work in the prospering city of Murray, Kentucky, have welcomed a new industry to their community. Its center is a new factory, devoted to the manufacture of Winslow Filters and Elements. This industry, with its personnel and payroll, is important to the people of Murray . . . but it is even more important to everyone who needs protection for the fuel and lubricating oils used in hard-to-replace and costly-to-repair engines or machinery. The new factory is important to all of you who place a premium on truly dependable filtration performance, because it means that there will be *more* of these fine products available for your use, and they can be shipped *quickly*, more *economically*, to wherever you need them!

In the East or in the West, the men and women who make Winslow Filters and Elements take genuine pride in their workmanship. Their skill and experience stand behind the amazing warranty that supports every Winslow product. Ask for full details!



WINSLOW FILTERS

Winslow Engineering Company 4069 Hollis Street, Oakland 8, California

A Graphic Method for Solving

Gas Pipe Line Pressure Problems

W. L. DUCKER

IN the design of gas transmission lines, as well as gathering systems, it is frequently desirable to know the pressure P_o at some intermediate point along a line for given conditions of inlet and outlet, P_1 and P_2 (Fig. 1), or to even plot the pressure profile of the entire length of the line. This latter circumstance is frequently encountered in transmission line design when studying a stepped or graduated wall thickness design, or in the selection of station lengths or intervals.

These problems may be readily solved for lines of either uniform or non-uniform diameter by the use of any one of the several accepted formulas for flow of gas through transmission lines, and the results in most cases would be independent of the particular flow formula that might be chosen.

Such flow formulas are involved, however, and the calculation of a pressure profile becomes a tedious chore. Much of the work can be alleviated by the use of an appropriate "gas pipe line slide rule", but even then the results may not be of high accuracy. The method proposed here will be found to yield highly accurate results more quickly on profiles requiring many pressure determinations along a line, and can be employed by the field man who has no special equipment and who is too rusty on his mathematics to cope successfully with the fractional exponents that characterize these gas line flow formulas.

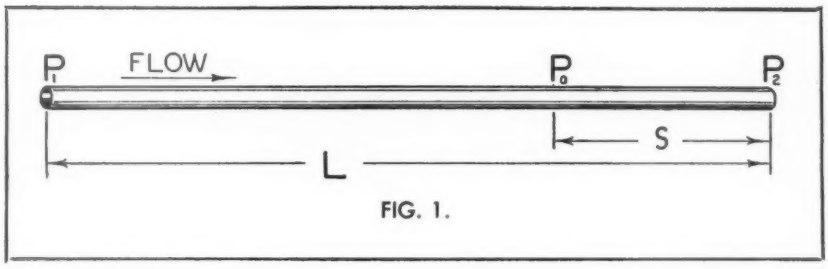


FIG. 1.

As the use or the application of this graphic method is considerably more simple than a rigorous proof of its validity, its application to the problem will be set forth first, and then following, for those interested, the proof of the theorem will be presented.

The Graphic Method

The graphic method of determining the pressure at any point along a gas transmission line is applicable *only to non-branching lines of constant diameter.* It is based on the relationship between the terminal pressures and the length of the line as expressed in the factor $\left[\frac{P_1^2 - P_2^2}{L}\right]$ which is contained in most of the accepted gas pipe line flow formulas.[1]

The following geometric construction will illustrate the application of this method to the solution of such problems. (See Fig. 2).

(1) To a horizontal line erect a perpendicular at C.

(2) From C, lay off to the left, to any convenient scale, the line outlet or discharge pressure $P_2 = \overline{CA}$.

(3) From point A, and to the same scale, lay off the line inlet pressure P_1 so that it intersects the vertical line through C at $P_1 = \overline{AD}$ (P_1 and P_2 in lb/in² abs.)

(4) With C as a center and $\overline{CD}$ as a radius describe the arc DB.

(5) From E, the midpoint of $\overline{CB}$, drop a perpendicular line.

N.B. The line segment $\overline{CE}$ now represents the total length of the pipe line, with flow from left to right as indicated. Assume that the line in question is 10,000 ft long and that pressure data are required at a point 6800 ft from the input end.

(6) Through C as shown lay a scale of any convenient graduation so that the total scale length of the pipe line (10,000 ft) intersects the vertical line through E.

With the scale thus in place locate the scale point where pressure data are required. (In this case it is 6800 ft as shown in Fig. 2.) From this point draw a vertical line to intersect $\overline{CE}$ at O.

(7) With O as a center and with $\overline{OB}$ as a radius, describe the arc BD′.

(8) Draw the line $AD' = P_o$; P_o being the absolute line pressure at the required point, to the same scale as was used in plotting P_1 and P_2.

It may be noted that as point O is moved toward point C (the input end of the pipe line) point D′ approaches point D, and pressure P_o approaches pressure P_1, the line input pressure; and as point O is moved toward point E (the discharge end of the pipe line) point D′ approaches point C, and pressure P_o approaches pressure P_2, the line terminal pressure.

Proof of the Theorem

Most of the various flow formulas that have been proposed for use in the calculation of pipe line flow of natural

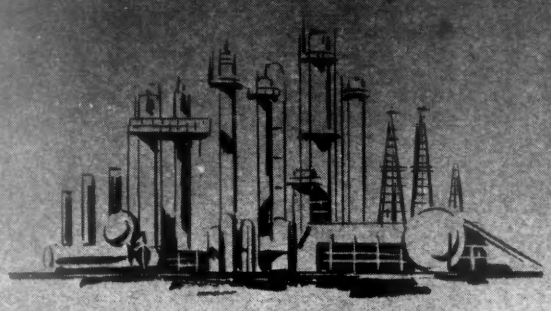
[1] For example, Weymouth's Formula:

$$Q = 18.062\, d^{8/3}\, \frac{T_o}{P_o}\left[\frac{P_1^2 - P_2^2}{GTL}\right]^{1/2}$$

where the terms are as defined under equation (1) of this article.

The Author

W. L. Ducker is head of the department of petroleum engineering at Texas Technological College, Lubbock, Texas. A graduate of Oklahoma University, Ducker joined Barnsdall Oil Company in the engineering department immediately after graduation. He was subsequently employed by Consolidated Gas Utilities Corporation, and later was chief engineer for Seismograph Service Corporation and Engineering Laboratories, Inc., and the Bovaird Supply Company. From 1941 to 1947 he was engaged in consulting engineering practice in Tulsa, Oklahoma, joining the Tech faculty in 1948.



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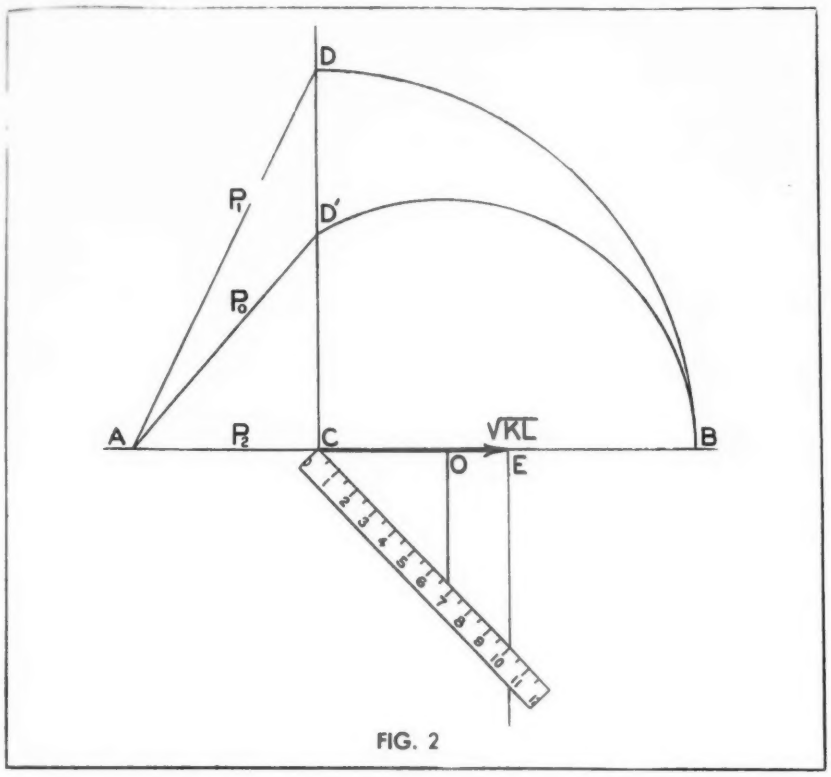

FIG. 2

gas may be reduced to the general form[2],

$$Q = 1.6156\, fd^{5/2} \frac{T_o}{P_o}\left[\frac{P_1^2 - P_2^2}{GTL}\right]^{1/2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

which is derived, with certain qualifying assumptions, from the general energy equation for any thermodynamic flow process, and wherein:

- Q = Volume of gas in cu ft per hr at base T_o and P_o
- T_o = Temperature base, °F abs.
- P_o = Pressure base, psia
- P_1 = Input pressure, psia
- P_2 = Outlet pressure, psia
- d = Internal diameter of the pipe, in.
- G = Specific gravity of gas (Air = 1.000)
- T = Temperature of flowing gas, °F abs.
- L = Length of line, miles
- f = Coefficient of friction. No units.

When such formulas are reduced to the general form, (equation 1), they will be found to differ primarily only in the nature or form of the friction factor f; whereas the pressure—length term $\frac{P_1^2 - P_2^2}{L}$ will be found to occur undisturbed in all such formulas.

Thus an examination of the general form of the flow equation (equation 1) or any of the special formulas will show that for any given line, operating under conditions of constant (steady state) flow, each of the terms of the equation will be constant, including the pressure—length term.

Thus:

$$\frac{P_1^2 - P_2^2}{L} = K \quad . \quad . \quad . \quad . \quad . \quad (2)$$

We can with equal validity, however, generalize the above expression so that it will describe the pressure-length relationship of *any portion or section of the given line,* it we let p_1 equal the pressure at the high pressure end of the section, p_2 be the pressure at the low pressure end of the section, and s be the length of the section.

Then:

$$\frac{p_1^2 - p_2^2}{s} = K \quad . \quad . \quad . \quad . \quad . \quad (3)$$

where p_1, p_2, and s are in the same units as the corresponding terms in equation (2) and where K is numerically equal[3] to K in equation (2).

It may now be noted that if p_1 is taken at the input end of the line, and p_2 is taken at the discharge end of the line, equation (3) becomes identical with equation (2).

In the problem of determining the pressure P_o (Fig. 1) at some intermediate point along a gas pipe line, it is convenient to consider the application of equation (3) to that portion of the line lying between the point of unknown pressure P_o, and the discharge end of the line at pressure P_2.

In this case p_1 in equation (3) becomes equal to P_o, and p_2 becomes equal to P_2,

$$\text{or} \quad \frac{P_o^2 - P_2^2}{s} = K \quad . \quad . \quad . \quad (4)$$

$$\text{or} \quad P_o^2 - P_2^2 = Ks \quad . \quad . \quad . \quad (5)$$

[3]As the value of the constant K depends upon the factors of the flow formula other than pressures and lengths, and if equation (3) is restricted to use only on sections of a given line to which equation (2) is applicable, then K of equation (2) is equal to K of equation (3). Until a numerical value is assigned to K, L and s may be in any units that may be convenient so long as consistency is maintained.

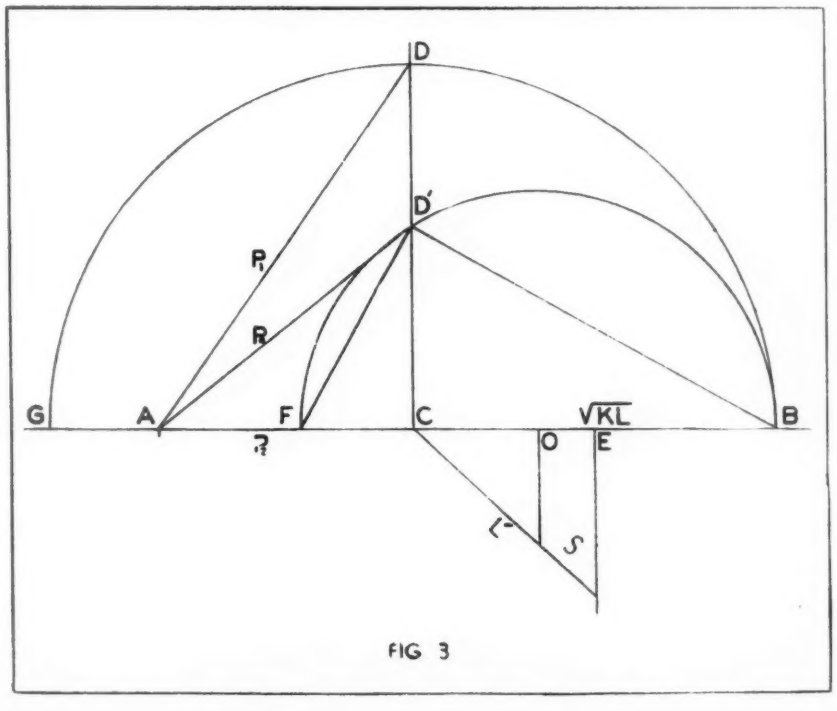

FIG 3

[2]"Flow of Natural Gas Through High Pressure Transmission Lines," T. W. Johnston and W. B. Berwald, U. S. Department of Interior, Bureau of Mines Monograph No. 6, February, 1935, Appendix No. 1, pp. 86-92.

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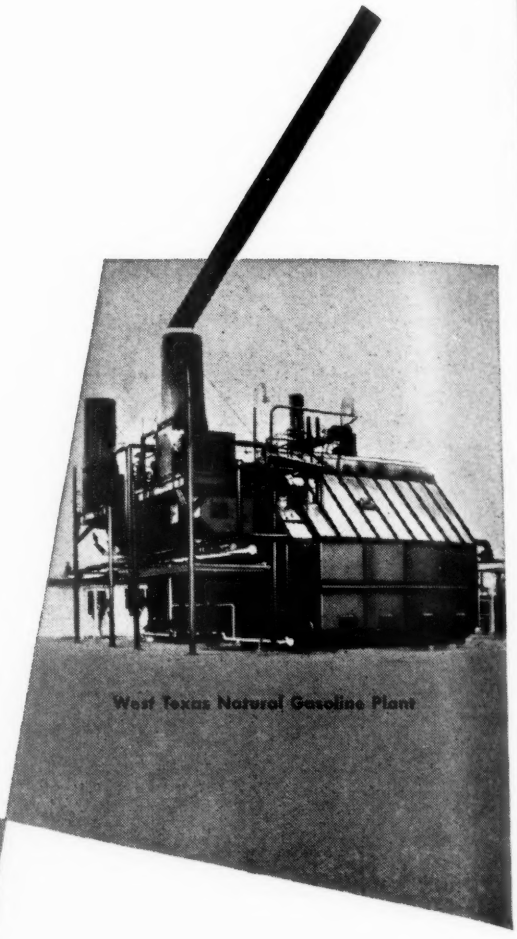
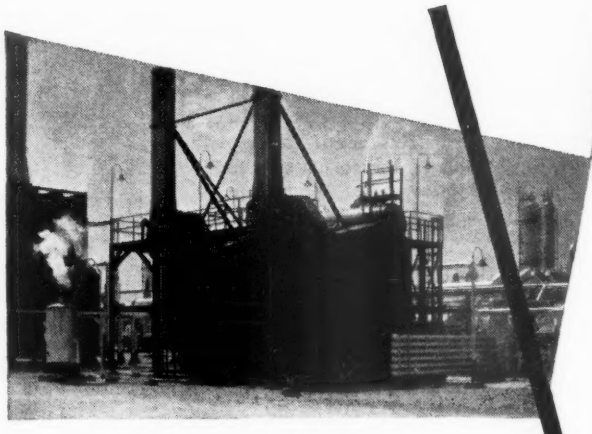
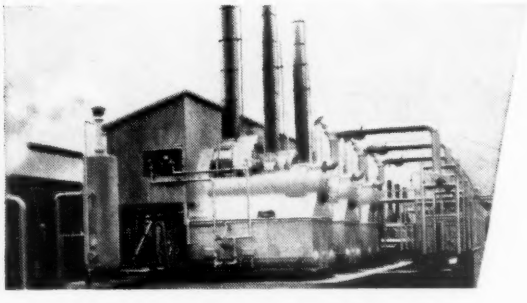


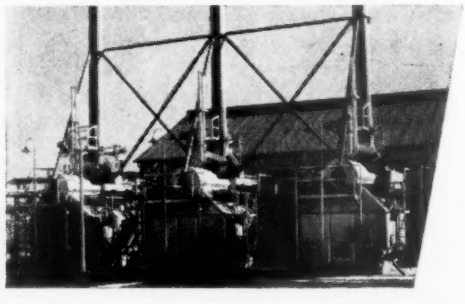
West Texas Natural Gasoline Plant



Central Texas Natural Gasoline Plant



▲ Louisiana Refinery



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and for the total line of length L,

$$P_1^2 - P_2^2 = KL \quad . \quad . \quad . \quad (6)$$

To the construction and notations of Fig. 2 add the following constructions and the notations shown in Fig. 3.

(1) Extend arc BD to G
(2) Extend arc BD′ to F
(3) Add lines $\overline{FD'}$ and $\overline{BD'}$
(4) Add notations $\sqrt{KL}$, L′, s′, as shown.

Then if equation (6) is rewritten thus:

$$P_1^2 - P_2^2 = \sqrt{KL}^2 \quad . \quad . \quad . \quad . \quad (7)$$

it has the form of a right triangle of sides P_2 and $\sqrt{KL}$, and with a hypotenuse of P_1. This right triangle is incorporated in Fig. 3 as triangle ACD and in which its altitude, and therefore also the radius of the arc GBD is equal to $\sqrt{KL}$.

In a like manner if equation (5) is rewritten thus:

$$P_a^2 - P_2^2 = \sqrt{Ks}^2 \quad . \quad . \quad . \quad . \quad (8)$$

it may also be plotted as a right triangle ACD′, Fig. 3, having the side AC common with triangle ACD, and having its altitude CD′ equal to $\sqrt{Ks}$

To Be Proved:

If the construction given for Fig. 2 gives for the line segment $\overline{CD'}$ a value of $\sqrt{Ks}$, then triangle ACD′ and equations (5) and (6), will be satisfied and the method will be valid.

By construction 6, of Fig. 2:

$$s'/L' = S/L \quad . \quad . \quad . \quad . \quad . \quad (9)$$

By similar triangles:

$$\overline{OE}/\overline{CE} = s'/L' = s/L \quad . \quad (10)$$

For any two circles, the difference of the diameters is to the difference of the radii as two is to one.

Therefore:

$$\overline{GF}/\overline{CO} = 2/1$$

or $$\overline{GF} = 2\,\overline{CO} \quad . \quad . \quad . \quad . \quad . \quad (11)$$

By construction 5, of Fig. 2:

$$\overline{GC} = 2\,\overline{CE} \quad . \quad . \quad . \quad . \quad . \quad (12)$$

Subtracting (11) from (12):

$$\overline{FC} = 2\,\overline{OE} \quad . \quad . \quad . \quad . \quad . \quad (13)$$

From (12) and (13):

$$\overline{FC}/\overline{GC} = \overline{OE}/\overline{CE} \quad . \quad . \quad . \quad (14)$$

But from (10) $\overline{OE}/\overline{CE} = s/L$, therefore:

$$\overline{FC}/\overline{GC} = s/L \quad . \quad . \quad . \quad . \quad (15)$$

As $\overline{FB}$ is the diameter, and D′ is on the circumference of a circle, Angle FD′B is a right angle, and triangles FCD′, FD′B and D′CB are all mutually similar.

Therefore:

$$\overline{FC}/\overline{CD'} = \overline{CD'}/\overline{CB}$$

or $$\overline{FC} \times \overline{CB} = \overline{CD'}^2 \quad . \quad . \quad . \quad (16)$$

From (15), and since $\overline{GC} = \overline{CD}$

$$\overline{FC} = \frac{s\overline{CD}}{L} \quad . \quad . \quad . \quad . \quad . \quad (17)$$

Substituting (17) in (16), and since $\overline{CD} = \overline{CB}$

$$\frac{s\overline{CD}^2}{L} = \overline{CD'}^2$$

or $$s/L = \overline{CD'}^2/\overline{CD}^2 \quad . \quad . \quad . \quad (18)$$

multiplying and dividing the first term of (18) by K, and taking the square root of both terms

$$\frac{\sqrt{Ks}}{\sqrt{KL}} = \frac{\overline{CD'}}{\overline{CD}} \quad . \quad . \quad . \quad . \quad (19)$$

As $\overline{CD}$ does equal $\sqrt{KL}$ by construction of triangle ACD, then $\overline{CD} = \sqrt{Ks}$.

Q. E. D.

* * *

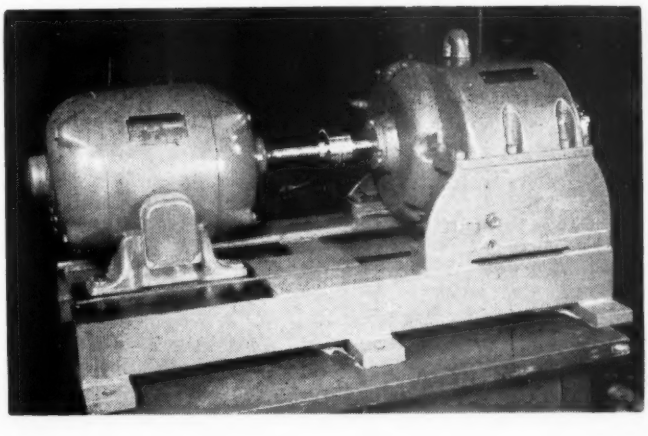
NEW LINE OF SPEED REDUCERS

Conservation of space is highly important in every modern industrial plant. The constant endeavor of every geared drive manufacturer is to reduce the size of his product as far as is practical and yet maintain sound design principles. The gearmotor with its integral construction of electric motor and particularly compact "in-line" speed reduction parts probably represents the ultimate in space saving.

At the same time, it is necessary in some industries to maintain a higher than normal degree of flexibility in their drives. Electric motors are purchased in large quantities from several different manufacturers and carried in stock, and the number of different ratings kept at a minimum. Final drive speeds may vary over a rather wide range so that taking full advantage of the compactness of gearmotors may be impractical. Consequently, the problem may dictate the use of separately coupled speed reducers.

The new Westinghouse type DB speed reducer is particularly designed to satisfy the conditions of this problem of coupled motor and gear drive and at the same time provide an appreciable amount of compactness with resultant saving in space. The mechanical parts (gearing, housing, etc.) of type C and type E gearmotors have been adapted to speed reducer construction by simple substitution of a bracket with necessary additional pinion shaft and bearings for the normally "built-in" motor used in gearmotor construction.

Eight sizes of units are available providing gear ratios from 6.25 to 58.3 to 1 and ratings from approximately ½ to 150 hp depending upon the particular gear ratio and motor speed required. Standardized fabricated steel bedplates to support motor and gear unit, as well as the necessary flexible couplings, are available for each size.



New speed reducer.

LAUGH with BARNEY

Teacher: "Who can tell me what the former ruler of Russia was called?"

Class: "Czar."

Teacher: "Right, and what was his wife called?"

Class: "Czarina."

Teacher: "Correct, and what were the czar's children called?"

A pause and then a small, timid voice piped up: "Czardines."

* * *

The Pi Phi greeted her boy friend with, "Notice anything different about me?"

"New dress?"

"No."

"New shoes?"

"No. Something else."

"I give up."

"I'm wearing a gas mask."

* * *

Tannin is now used successfully for removing sulfur from crude oil. In other days tannin was also considered mighty good for removing the bad habits of children.

* * *

A Scotsman was leaving on a business trip and called back as he was leaving, "Goodbye all, and dinna forget to take little Donald's glasses off when he isn't looking at anything."

Some thirst after knowledge, some after fame, and some after money—but everybody thirsts after popcorn.

* * *

"What was your Sunday School lesson about?" asked the mother as her small daughter returned from church.

"About a man named Solomon," the child answered.

"And what did you learn about Solomon?"

"The teacher said he had 300 wives and 700 cucumber vines."

* * *

"Men make me tired."

"Stop chasing them."

* * *

The Republican senator who was on his way to a vacation resort in the South, found himself on an ancient "dinky" train, and as the tiny engine trembled to a halt in a small town, he was surprised to see a good-sized crowd gathered at the station.

A portly, florid-faced citizen detached himself from the gathering, boarded the train, and barged toward the great man.

"Senator," he said, "they'll water here an' cool off the engine. It'll take thirty minutes, at least, and you'd do us a great honor by steppin' to the back of the train an' makin us a little talk. It'd mean a lot for us just to say a U.S. senator had addressed our citizens."

The senator smiled indulgently and walked to the rear platform. Not wishing to discuss politics, he decided to say a few words about the privilege of being an American, and then quote directly from the Declaration of Independence.

He had just begun on the Declaration when the sourfaced old conductor, who had been listening intently, began yelling, "All aboard!" at the top of his voice and pulling frantically upon the cord.

The surprised senator exclaimed, "Why, I thought you took water here—that we had a thirty-minute wait."

"Ain't waitin' today," came the snappish reply. "I'll have you know I'm a Democrat to the bone, an' I just couldn't stand it no longer when you started talkin' that pure Republican propaganda."

* * *

Said Beulah, the cow: "My owner feeds me very well, but there are a couple of times a day when I think he's an awful jerk."

* * *

A young businessman who was a deacon in his local church, was in New York on business. He was to purchase a new sign to be hung in front of the church. Before he left home, he copied the motto and the dimensions. When he arrived in New York, he discovered that he had left the paper at home.

He wired his wife: "Send motto and dimensions."

An hour later the reply came in, and when the girl, who had just come on duty, read the telegram, she fainted.

The message read: "Unto Us a Child Is Born, 6 feet long and 2 feet wide."

* * *

"I want an explanation and I want the truth," stated the wife irately.

"Well, make up your mind," he snapped. "You can't have both!"

* * *

The marriage ceremony had just been concluded and the groom took out his billfold and inquired, "What do I owe you, Reverend?"

"I do not charge for this service," replied the minister, "but you can pay me according to the beauty of your bride."

"Fair enough," said the young man, and he handed the minister a quarter.

The minister raised the bride's veil, took a look and dug into his own pocket.

"Here's fifteen cents change, my friend."

* * *

Employer, to newly hired steno: "Now I hope you thoroughly understand the importance of punctuation?"

Steno: "Oh, yes, indeed, I always get to work on time."

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OIL and GAS TRADE NEWS

Ground Water Film Out

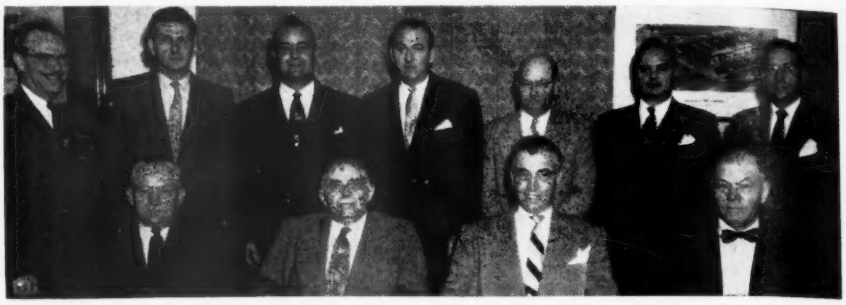
A new 16 mm color motion picture with narration has been completed by Layne and Bowler, Inc., and associate companies, on ground water development. The picture entitled "Deep Water", depicts a complete story of well water development from the initial survey through engineering, construction, testing and actual use, including "on the scene shots" of Layne men and equipment at work on water development projects. This picture will enable sales engineers to portray advantageously the services offered by Layne ground water development companies.

Hough Contract Obtained

The Meili-Blumberg Corporation, New Holstein, Wisconsin, has just completed negotiations with The Frank G. Hough Company for the acquisition of its line of tractor sweepers. Meili-Blumberg will now distribute as well as continue the manufacture of all such sweepers under the M-B trademark.

Twin Disc Open House Held At Dallas Factory Branch

Celebration of completion of its new Dallas, Texas, factory branch was held recently by Twin Disc Clutch Company. Numerous friends, business associates, and officers and key personnel from the Racine, Wisconsin, and Rockford, Illinois, plants attended. The office will be manned by H. A. Davis, district manager; N. E. Brighton, office manager; H. T. Peck, sales engineer; H. C. Gillum, service engineer; M. M. Brown, warehouseman, and Miss Loraine Shelton, secretary.



Baash-Ross Tool Company officials meeting recently are, front row: H. C. Ross, vice president; L. F. Baash, president; F. L. Tooley, executive vice president and general manager; A. F. Brown, vice president. Back row, Glenn D. Johnson, vice president in charge of research and development; John L. Dickmann, chief engineer; E. M. Gearke, general sales manager; T. A. Boyd, secretary-treasurer; Wm. J. Williams, works manager; H. Wotkyns, vice president in charge of Mid-Continent operations, and L. J. Laird, assistant general sales manager.

Canadian Subsidiary Formed

The headquarters of Girdler Corporation of Canada, Ltd., have been established at Toronto, Ontario, in Suite 4, 143 Yonge Street. J. F. Babbitt is the Canadian representative of the company, which is a subsidiary of The Girdler Corporation, Louisville, Kentucky.

Waukesha Lab Underway

Ground has been broken for the new experimental and research laboratory of the Waukesha Motor Company, Waukesha, Wisconsin, and preliminary construction is under way. This new building, estimated to cost about $175,000.00 will be one story in height, and rectangular in shape, measuring 90 by 201 ft. Present plans call for the completion of the structure in January, 1953, when much of the elaborate research equipment now used by the company will be transferred to this new laboratory.

Overvold Named Agents

Appointment of Overvold Distributing, Inc., 13 Fourth Street, Moorhead, Minnesota, as distributor for Nordberg 4FS diesel engines is announced by Nordberg Manufacturing Company. In this position the firm will cover North and South Dakota, northwestern Minnesota, northern Nebraska, and eastern counties of Montana and Wyoming for Nordberg. President and sales manager is Ernest Overvold and H. Overvold is vice president and office manager.

Eureka Officers Named

The Eureka Company has completed a process of reorganization, election of new officers and board of directors. New officers are: Samuel D. Blowitz, president; W. K. Wilson, vice president; E. Sterling Ferguson, secretary-treasurer. Henry Mezori and Mrs. Juanita Allen are directors.

Attending Twin-Disc Open House are: First row, Jack Mussler, sales manager, Continental Supply; G. W. Walton, vice president, Dresser Equipment. Second row, N. F. Adamson, vice president - sales, Twin Disc Clutch; W. T. Powell, executive vice president, Emsco Derrick and Equipment, and J. H. Batten, president, Twin Disc. At left is Twin Disc's new Dallas factory branch at 1511 Turtle Creek Boulevard.

mulsion Treaters

Patent Pending

he job done

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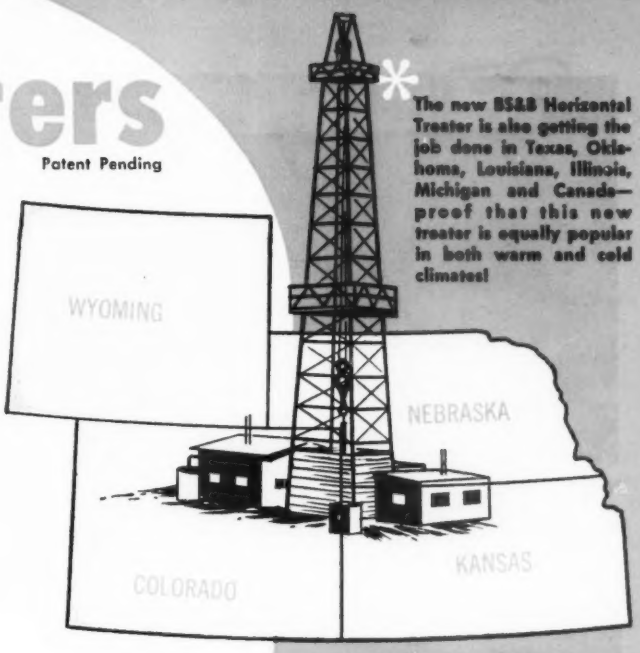


The new BS&B Horizontal Treater is also getting the job done in Texas, Oklahoma, Louisiana, Illinois, Michigan and Canada—proof that this new treater is equally popular in both warm and cold climates!

he requirements are rigid as to water content, and the BS&B ontal Emulsion Treater is keeping the water content within the um. The treaters, in some cases, are handling several wells different emulsion characteristics.

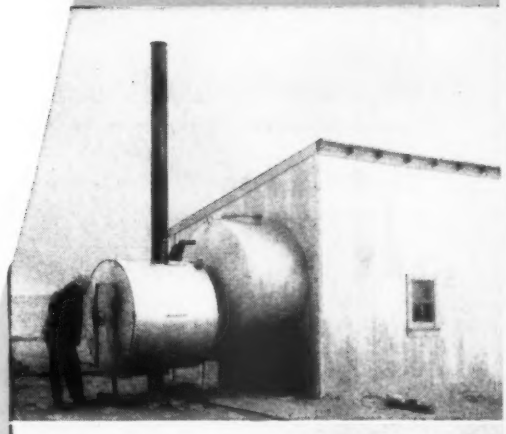
Operators Like the Steam Chest

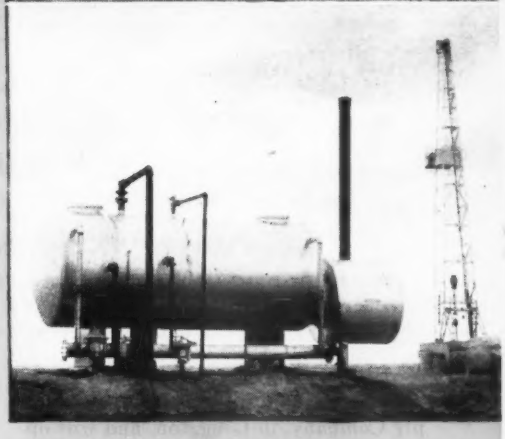
rdless of location or type of oil being treated, all operators cularly like the steam chest . . . the big feature of the BS&B ontal Emulsion Treater. There is greater efficiency with direct ng of the emulsion—no wasteful heating of wash water. In the Kansas particularly, where there is a high content of alkali, the steam chest es one heretofore serious problem . . . fire box burnouts are practically nated. Because lower temperatures permit minimum heating of salt water, sion is reduced. Low skin temperatures on the steam chest minimize the ce of salt deposits and eliminate any possibility of "coking."

e New BS&B Horizontal Emulsion Treater Popular in Warmer Climates, Too

BS&B Horizontal Emulsion Treater has been tried and tested in warmer tes, too. Operators are quick to recognize BS&B as being first with a m chest for a horizontal emulsion treater. This is a closed system requiring ake-up water . . . it is removable . . . and it's built to A.S.M.E. requirements. large, quiet free water knockout provides a larger surface for separation ee water . . . which is removed without being heated. Heat load on the ng unit is reduced. A higher gravity crude is possible with the large steam ng and settling section. Hot gas produced in this section is mixed with gas from the free water knockout section, causing the heavier gas fractions ondense and be recovered in the oil.

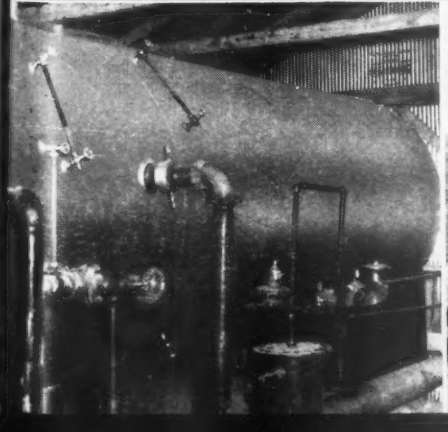
B Horizontal Emulsion Treaters are available for very . . . Sizes 6'x14'—6'x21'—8'x21'—10'x21' . . . iliary units available for attachment to the treater at tory or in field with minimum of time and effort.

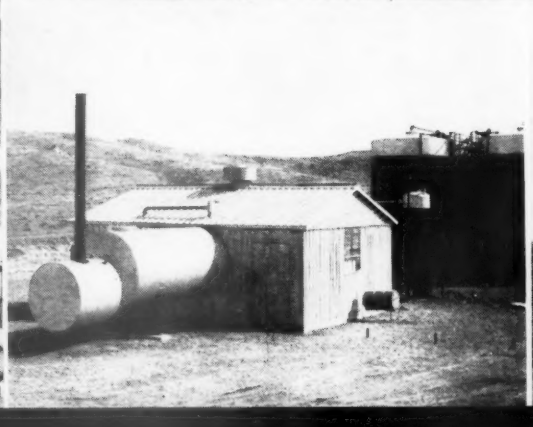


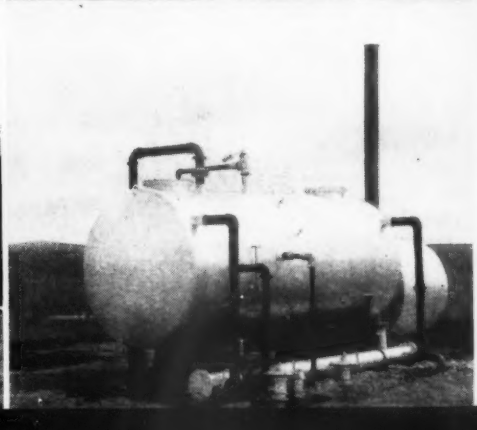


BLACK, SIVALLS & BRYSON, INC.

Oil & Gas Equipment Division, Department 1-C6, 2131 Westwood Blvd., Oklahoma City, Oklahoma.

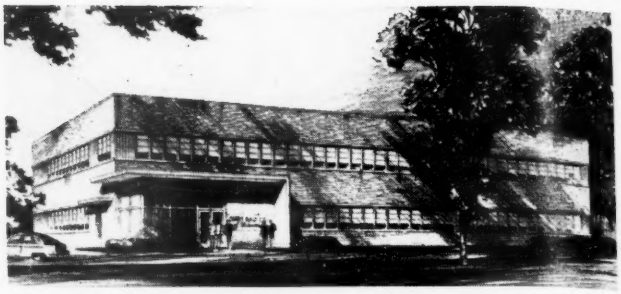




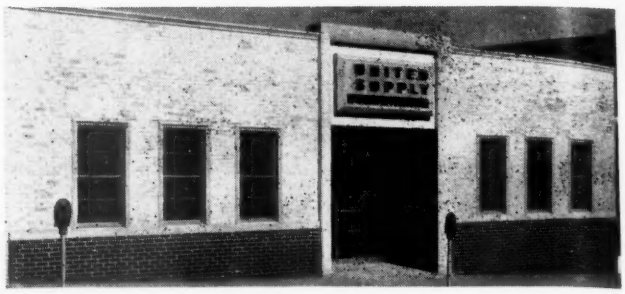


National Lead Company stockholders inspecting a well logging truck of the company's Baroid Sales Division at the 60th annual meeting in Sayreville, New Jersey. This is probably the first truck of its type to be seen in the East, as practically all current oil well drilling is concentrated in the western part of the country.

Rosson-Richards newest pipe coating and wrapping yard in Charlotte.



Chain Belt Company's administration building at 4701 W. Greenfield Avenue, Milwaukee, Wisconsin. For the past 50 years, the firm had its executive headquarters at 1600 W. Bruce Street, Milwaukee.



United Supply's new headquarters office building.

Pipe Wrapping Yard Open In North Carolina City

John Rosson and "Dutch" Richards of Rosson-Richards Company announce the opening of their newest pipe coating and wrapping yard in Charlotte, North Carolina. This is the 4th permanent yard to be opened since the company began operations. The Charlotte installation will serve the many oil and gas companies in the Piedmont area. It has the capacity to coat and wrap from 10,000 to 30,000 ft of pipe per day in a range of pipe sizes from 30 down to ¾-in.

Continental Expands Its East Texas Facilities

Plans for an important expansion of Continental Motors' engine sales and service facilities in the East Texas area have been made public by C. J. Reese, president of the company. Reese announced that the company has purchased the business, stock, and equipment of the Standard Engine and Supply Company, in Greggton, and will operate it as a distributorship under its Southwestern branch at Dallas, Texas.

BS&B Export Office Set Up

Henry A. Ruysser, Jr., vice president and general manager of sales, Black, Sivalls & Bryson, Inc., has announced

H. L. Mumma

Hans Unger

the establishment of a new export department, and the appointment of Harlan L. Mumma as BS&B's Eastern regional sales manager. The new export department, at BS&B's Kansas City general offices, will be under the direction of Hans Unger, new export manager for the company. Unger has spent 27 years dealing with export sales. He has visited almost every major trade territory in the world, representing numerous American companies abroad.

New Headquarters Open

United Supply and Manufacturing Company is now in its new headquarters office building at 911 S. Main, Tulsa, Oklahoma. The modern one story structure covers a 50 by 140 ft lot. The company was founded in 1936 by H. Brooks Gutelius, Sr., president. Other officers are H. Brooks Gutelius,Jr., Frank Wood, and F. W. Fisher, vice presidents and E. F. Geary, comptroller.

Du Pont to Mark 150th Anniversary

The 150th anniversary of the establishment of E. I. du Pont de Nemours and Company will be marked July 18 at the site of the first Du Pont powder mills on the banks of Brandywine Creek, near Wilmington, Delaware. The ceremonies, which will include an historical dramatic prologue, addresses by company officials, and the dedication of a marker on the site of the first plant, are the focal point of observances by the Du Pont Company. About 6000 representatives from 71 plants, retired employees, members of the du Pont family, and guests are expected to be on hand.

Field representatives and sales officials of the Guiberson Corporation. Occasion was the recent spring sales meeting of the company held at the Guiberson plant in Dallas, Texas. Attending were, front row: C. L. Forcum, C. A. Teel, W. E. Nolan, Jr., D. L. Fry, R. Z. Mendenhall, H. S. Zane, Jr., A. P. Smith, R. L. Lindsay, D. L. Moss, L. E. Brookover, H. W. Haltom; middle row: A. E. Brummett, J. P. Killingsworth, R. A. Day, H. M. Cherry, R. J. Foreman, L. T. Ferguson, E. E. Embury, W. V. Phillips, W. R. Forcum, J. T. Anderson; back row, O. A. Hess, R. L. McAdams, C. E. Lance, R. W. Lindsay, Jr., F. F. Bridwell, D. W. Watson, D. L. McGill, L. E. Vessels, B. M. Matthews, D. Burris, D. B. Craver.

Here's a Boom That REACHES For Extra Jobs

BUCYRUS ERIE
HYDROCRANE

The all-hydraulic Bucyrus-Erie 3-ton Hydrocrane with telescoping boom reaches into windows and box cars . . . over fences . . . under beams and overhanging branches . . . between wires and rafters — without moving crane an inch! Boom extends and retracts a distance of eight feet.

The outstanding advantages of telescoping boom plus precision hydraulic control combine to make the Hydrocrane ideal for moving heat exchangers, condensers, valves . . . unloading casing and tubes . . . handling bits, stems, pipes . . . placing derrick floor timbers . . . erecting tanks and separators . . . changing well heads, Christmas tree, etc. . . . stockpiling materials.

Here is the made-to-order crane for in-between jobs — work that shouldn't tie up expensive heavy equipment, yet is too big for hand labor. Get full details. See your Hydrocrane distributor or write for descriptive literature. 155H52

- **Sure-Footed** — outriggers extend or retract hydraulically in seconds.
- **Speedy** — 50 mph. top highway speed.
- **Squeeze-in Specialist** — shortest tail swing of any crane, size for size.
- **"Dead Man" Control** — if operator lets go of levers, load stops dead.
- **Velvet Smooth** — all work functions powered by a cushion action hydraulic system.

● Every crane function fully hydraulic — boom hoist, load hoist, swing, boom telescope, outrigger set and retract, bucket close. Available with quickly interchangeable dragshovel front-end.

BUCYRUS-ERIE HYDROCRANE DIVISION · South Milwaukee, Wisconsin

Aerial view of the new office and plant facilities. Right, R. C. Baker, founder and president of Baker Oil Tools greets Smith Vroman, first superintendent of Baker's Coalinga plant, who built the original Huntington Park plant and served as superintendent until 1929.

Baker Oil Tools Opens New Offices

The new home of Baker Oil Tools, Inc., had its formal opening on Friday, April 18, with plant tours and a continuous buffet served to hundreds of petroleum industry guests. On Saturday, April 19, the open house was continued for stockholders and the families of Baker employees.

Baker's new facilities, at 7400 East Slauson Avenue, in Los Angeles, include the executive offices of Baker Transworld, Inc., a wholly owned subsidiary. The shop occupies more than 160,000 sq ft, while the office building has over 23,000 ft of floor space.

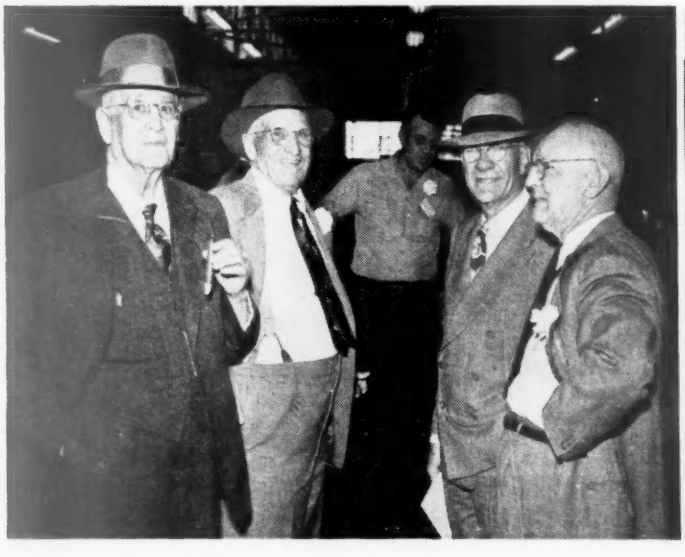
Designed and built by Baker personnel, the new home is the third headquarters structure occupied by the company since its founding as the Baker Casing Shoe Company in Coalinga, California, in 1913. In 1921, Baker opened its plant and offices in Huntington Park. These remained the headquarters of Baker Oil Tools until the new building was completed in October, 1951. The founder of the company, R. C. Baker, Sr., now in his eightieth year, remains active as president.

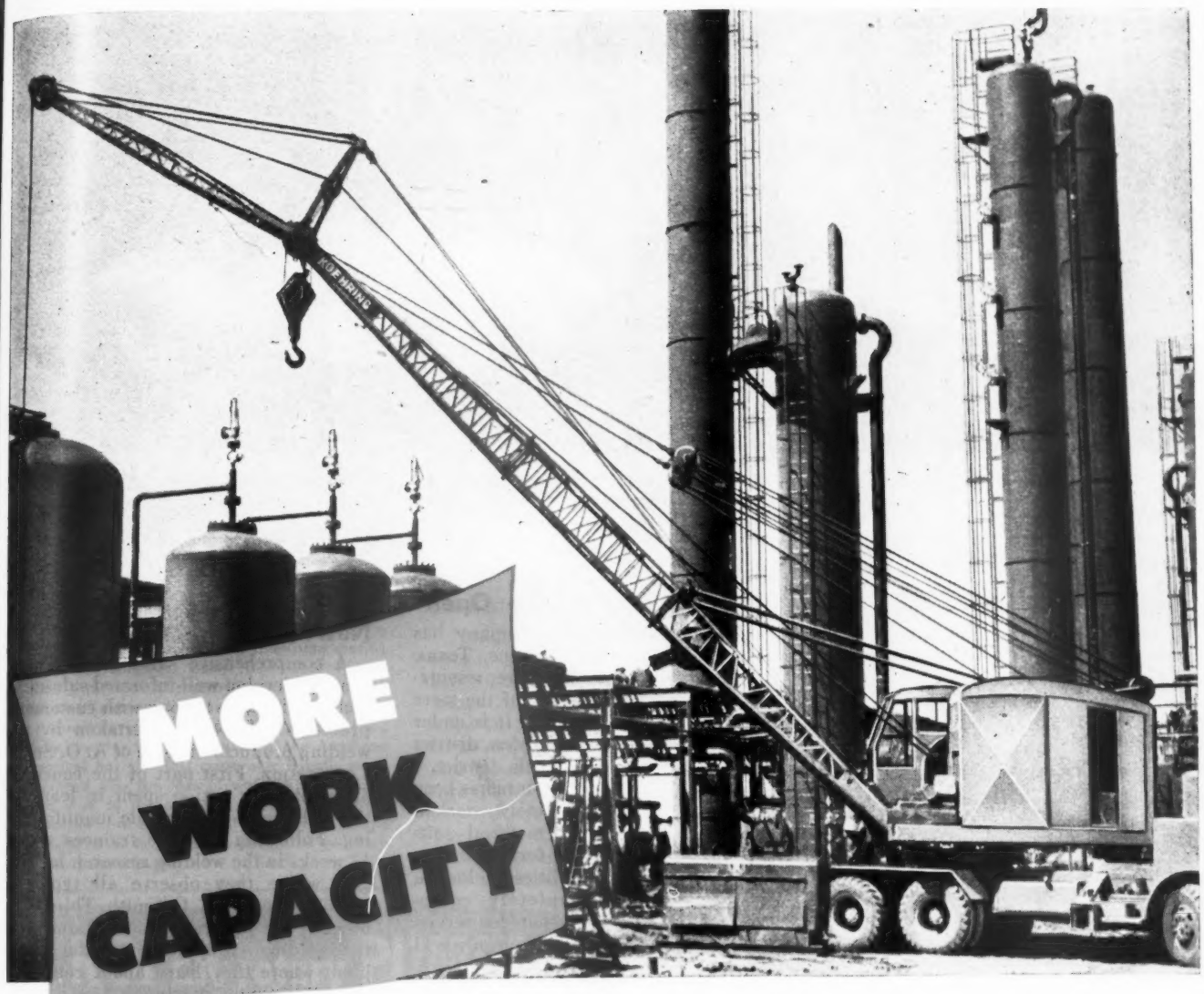
Baker maintains widespread facilities for serving the oil industry on a nationwide basis and internationally.

In the United States, Baker operates a western and a central division. The western division, with headquarters in Los Angeles, includes 11 branch offices in California and the Rocky Mountain area. The central division, with headquarters at Baker's factory and office building in Houston, Texas, includes 34 branch offices in the Gulf Coast and Mid-Continent areas.

Baker's main export office is in Los Angeles, with branches in New York, Houston, Tulsa, and Dallas. The company is also represented in Trinidad, Argentina, and Mexico. Baker Transworld, Inc., a wholly owned subsidiary of Baker Oil Tools, Inc., represents and carries on Baker's business in Eastern and Western Venezuela and in Canada. It maintains division offices in Anaco, Eastern Venezuela; Maracaibo, Western Venezuela, and in Calgary, Alberta, Canada. ★ ★ ★

Three generations of Baker shop superintendents compare notes. They are: Smith Vroman, R. C. Baker, C. E. Burt, shop superintendent from 1929 to 1941, and C. A. McDonald, who became plant superintendent in 1941 and is now production manager of Baker's LA headquarters. Right, R. G. Garretson, technical adviser to Baker's export department chats with Ted Sutter, general manager and executive vice president of the organization. Although the new home of Baker Oil Tools houses the executive offices, it remains essentially an oil field firm.





WITH KOEHRING 25-TON 304 CRANE

ON ALL heavy lifting jobs, the reserve strength and operating stability of Koehring heavy-duty 304 Crane gives a definite advantage in extra work capacity. You get 13.9-ton lift and boom lengths up to 75 feet on crawler mounting . . . 25-ton lift capacity and maximum reach up to 110 feet, including jib, on rubber-tired truck or cruiser mounting.

With heavy-duty strength beyond rated capacities, the 304 also has a wide work range for dragline or clamshell operation . . . and plenty of power, stamina and weight-stability for toughest digging with ¾-yard shovel or hoe.

With every 304 crane or excavator attachment, big Koehring booster clutch cuts normal lever pull over 50% . . . reduces operator fatigue, yet retains accurate "feel" of load. Heat-compensator spring makes clutch tension changes automatically . . . keeps operator and machine working at top efficiency at all times.

For specific figures on 304 work capacity, and information on all mechanical advantages, contact your Koehring distributor, or write us. Other sizes: 7¾ to 79½ tons lift capacities . . . ½ to 2½ yards dipper capacities.

KOEHRING COMPANY, Milwaukee 16, Wis.

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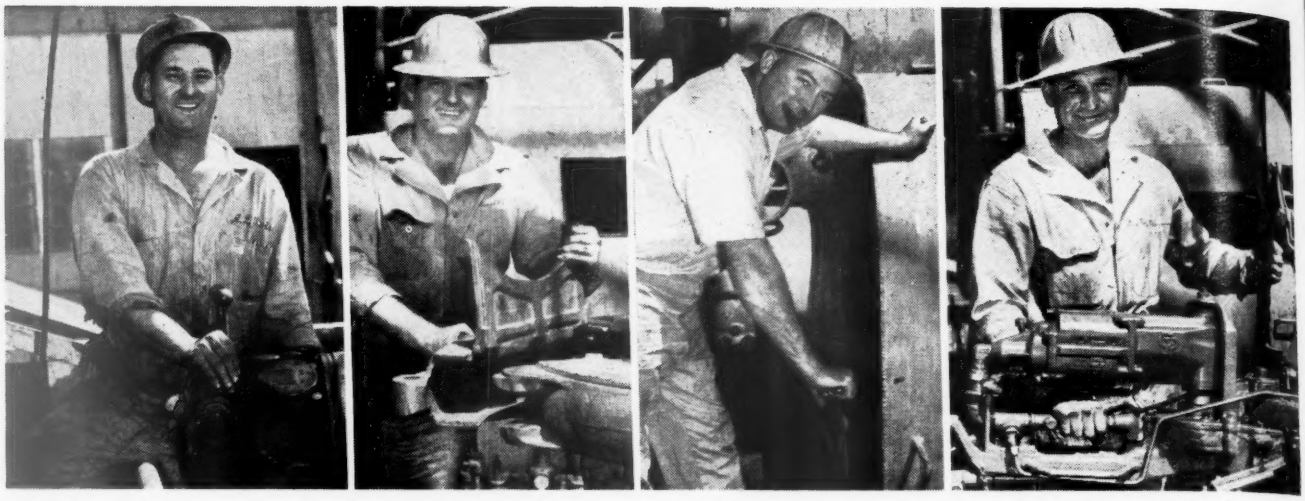
K274

KOEHRING *heavy-duty* CRANES

7¾ to 79½ TONS lift capacities . . . EXCAVATORS ½ to 2½ yards



Four sales engineers graduated recently from the Byron Jackson Company training program. As shown above they are: A. L. Gooden, E. Gene Mitchell, W. W. Simpson, Lee Roy Harryman. This program will enable the four field representatives from the PB division of the company to familiarize themselves with the oil tools they will now handle in addition to the regular line of PB rubber products. Although the men have been in the field for a number of years, it was necessary to acquaint them more fully with BJ oil tools so they could make field repairs.

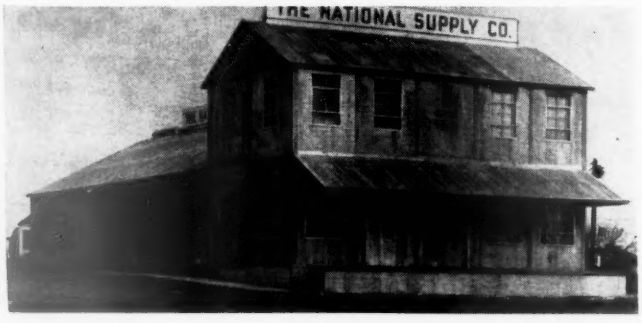
Distributorship Extended

Gustin-Bacon Manufacturing Company has extended the distributing territory of Western Fiberglas Supply Company, San Francisco to include the entire Pacific Coast and Alaska. Western Fiberglas has been distributor in the Los Angeles and San Francisco area.

National Supply Store Open

The National Supply Company has opened a new store in Abilene, Texas. J. R. Walker, former sales representative at Abilene, is manager of the store at 2118 S. Treadway Street. It is under the supervision of J. E. Warden, district manager of the Wichita Falls district.

The store has been completely stocked with material suitable for the area. Facilities include a completely equipped shop for servicing downwell pumps. Three representatives work from the location.



At left, National Supply's Abilene store.

A. O. Smith Sets Up New Training Program

A comprehensive sales training program to develop well-informed salesmen-technicians, able to cope with customers' problems has been undertaken by the welding products division of A. O. Smith Corporation. First part of the course is an eight-week period spent in learning the techniques of electrode manufacturing. Following this, the trainees spend 12 weeks in the welding research laboratory where they observe all types of welding used by A. O. Smith. Third segment of the program places trainees in the welding equipment manufacturing plant where they learn about construction of welding machines and how to use them.

Following this students will work in the divisional sales office at Milwaukee.

Sucker-Rod Pumping System Study Gets Underway

A three-year study of the technology of sucker-rod pumping systems has been outlined by representatives of the industry, got underway June 1. A Steering Committee has been formed and currently is inviting industry-wide support for the program. The committee is composed of L. A. Little, Lufkin Foundry and Machine Company; J. R. Mahan, National Supply Company; L. A. Ogden, The Pure Oil Company, and H. H. Kaveler, Phillips Petroleum Company, chairman. Chairman Kaveler points out that oil producers today still use what is basically the "pitcher" water-well type of pump used by Colonel Drake. The present pumping system is largely the product of trial-and-error development. "Such development has been of practical value. The important fact is, however," according to Kaveler, "that no sound technical approach based upon scientific investigation has ever been conducted on the question of what constitutes better design and operating practice."

Servicemen's Factory Training School of the Unit Crane and Shovel Corporation was held recently. The school operated five days under the supervision of James Strode, service manager. Attending were: Front row, R. McCracken, Barker Equipment; E. Madlom, Moorman Equipment; J. Vance, K. C. Diesel Power; W. Jackson, H. B. Owsley and Son; L. Schaefer, parts manager, Unit Crane and Shovel. Second row, J. Klipsch, Fred Malotte Machinery; S. Wnorowski, North Jersey Equipment; G. Hardy, Ontario Equipment and Supply; D. McLain, and S. B. Kopp, Machinery, Inc. Third row, A. Manke, Diamond Colloton Equipment; H. Shugart, Midwestern Engine and Equipment; A. Rinko, Mid-State Contracting Equipment; H. Jordan, Ken Smith Machinery; R. Schindler, A. E. Hudson; James Strode. Fourth row, G. Suitor, Hi-Way Machinery; F. Linehan, Inland Diesel and Machinery; C. Jones, Priester Machinery; A. Jarvi, Arrow Contracting Equipment; F. Van Drunen, Miller Equipment; and V. Donner, A. E. Hudson.

Cameron Iron Works, Inc. salesmen held a two-day meeting recently at the Shamrock in Houston, Texas. Pictured, front row, are: M. L. Hooks, Paul Edkin, I. M. Baker, A. D. Cathey, J. W. Harris, J. B. Ray, J. R. Jerabeck, T. Putnam, W. L. Reynolds, H. E. Brown, J. A. Tennant. Back row: W. H. Phillips, Ralph Neuhaus, G. Teer, H. Helms, W. R. Davis, D. V. Clemons, J. H. Page, R. F. Farmer, O. L. Lorehn, and F. H. Isaacks.

Gerry Baker (left), research chemist of Oil Base, Inc., explains a laboratory demonstration to Gil Martyn (right) of television station KTLA, Los Angeles. Baker and Don Wilson (center), director of research at Oil Base, were invited to explain the use of drilling fluids on a recent television program, "Magazine of the Week", under the sponsorship of the American Chemical Society. This apparatus visually demonstrated how the loss of water from a water base mud to the oil sand, blocks production, while the loss of diesel oil from Black Magic oil base mud to the oil sand has no blocking action on production.

Plant Name Changed

What has been known as the Dunellen, New Jersey, plant of Worthington Corporation has been redesignated as the Plainfield Works, at Plainfield, New Jersey, according to F. J. Whelan, sales vice president. Though known as the Dunellen Works since 1943 when purchased from Ransome Machinery Corporation, the plant is not actually in the town of Dunellen. It is partly in Plainfield and partly in Piscataway Township, which is between Plainfield and Dunellen.

Saskatchewan Store Open

National Supply Company, Ltd., has opened an oil well equipment and supply store at Swift Current, Saskatchewan, Canada. This is National's first store in Saskatchewan. Important discoveries of oil and gas in Saskatchewan, and the accelerated wildcatting program throughout the province, prompted the opening of the store at Swift Current. Travis W. G. Kirkham is store manager under the supervision of R. W. Burns, division manager.

Totco Completes Meetings

H. H. Peters, vice president, and E. G. McConnell, Mid-Continent manager, of Technical Oil Tool Corporation, announced the recent completion of the firm's annual series of sales and service meetings in the Mid-Continent area. McConnell stated that meetings were held successively in Houston, Odessa, and Oklahoma City, with Totco service representatives from the surrounding areas in attendance. Over 28 men, including two representatives from Wyoming, were present.

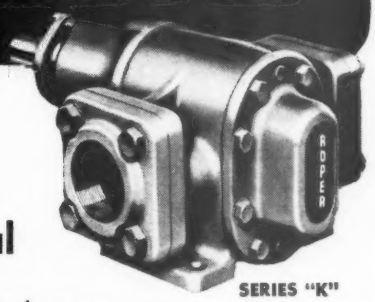
E. G. McConnell

BS&B Opens Utah Branch

Floyd C. Myers, manager of branch operations for Black, Sivalls & Bryson, Inc., has announced the opening of a new BS&B branch in Vernal, Utah. Gerry Clayton is manager of the new branch, situated on East Highway 40.

ROPER rotary PUMPS

DEPENDABLE SERVICE FOR A WIDE RANGE OF USES



SERIES "K"

- **Quiet**
- **Efficient**
- **Economical**

The *Series K* pump shown — for hydraulic service and fuel supply — is one of four standard models in the Roper line. Others include: *Series F* for use with clean liquids of all kinds; *Series H* for high pressure applications, especially hydraulic mechanisms; and *Series 3600* for general purpose work handling thin or thick liquids. Roper Pumps are noted for quiet operation, high volumetric efficiency, and ruggedness coupled with compact design. Models are standard fitted or bronze fitted; can be supplied with or without built-in relief valve. Sizes range from 3/4 to 300 G.P.M. — Pressures to 1000 P.S.I. Send for catalog to know complete details.

GEO. D. ROPER CORP.
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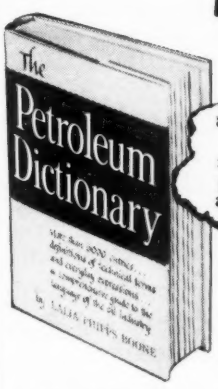
ROPER Rotary Pumps

AT LAST—

The *petroleum* industry has a *dictionary* of its own



acid treatment
A treatment by which asphalt is removed from petroleum in order to improve its end products. [D]
aclinic, adj.

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Two Branch Offices Opened

McCullough Tool Company has announced the opening of two new service branches at Williston, North Dakota and Vernal, Utah. This raises the total McCullough branches operating in major oil fields to 33. Elmer Moody, formerly Bakersfield, California branch manager, is now branch manager at Williston. Stan Hendrickson has been appointed manager of the Vernal, Utah service branch. He was formerly assistant manager at the McCullough Ventura, California service location. Frank Sweet, formerly assistant service manager at the main plant and western division headquarters in Los Angeles, has been appointed branch manager at Bakersfield, replacing Moody.

New Company Set Up

A new company, Abbott and Biddle, has been formed to manufacture die-formed packing rings or washers. Their plant will be situated at 2413-27 Federal Street, Philadelphia, Pennsylvania, and any information about die-formed rings can be obtained by writing to them.

Chicago Sales Office Opened by Midwestern

Midwestern Engine and Equipment Company recently announced the establishing of new sales representation in Chicago, Illinois. Fred J. Steinmiller has joined Midwestern for the express purpose of handling the company's pipe line wrapping and supply items for the Indiana, Illinois, Iowa, Wisconsin, and Minnesota area.

F. J. Steinmiller

A graduate of Loyola University in Chicago, Steinmiller has been engaged in sales and transportation activities in the Chicago area for a number of years.

Cleco Appoints Agents

The Cleco Division of the Reed Roller Bit Company, Houston, Texas, has announced the appointment of Charles H. Harden and Company, Inc., Seattle, Washington; Highway Equipment and Supply Company, Lincoln, Nebraska; Long Beach Welders' Supply, Long Beach, California; and E. W. Harman Company, Columbus, Ohio, as distributors for Cleco products in their areas.

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custom-built
to fit the job!

Work boats, pleasure craft

Drilling rigs, centrifugal pumps, generator sets

Earthmovers, logging yarders and loaders

Buses and highway trucks

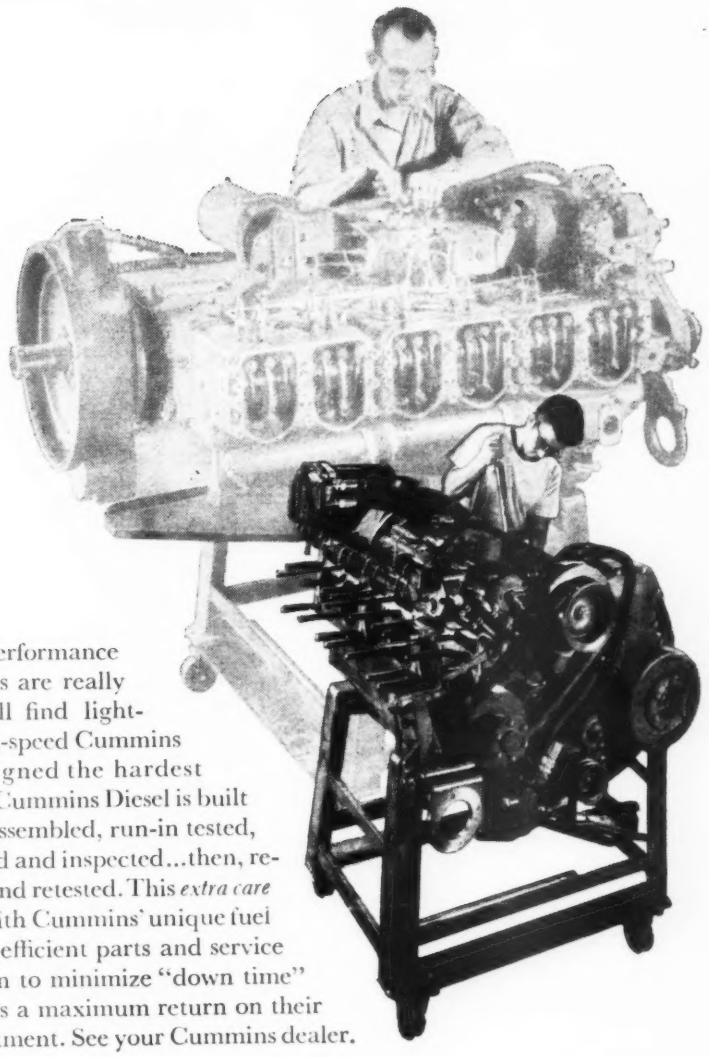
Off-highway trucks, crawler tractors

Shovels, cranes, industrial locomotives and switchers

Lightweight, high-speed Diesels (50-550 hp) for these and many other uses

Cummins® Diesels do so many jobs so much better

they're
BUILT NOT ONCE BUT TWICE



Wherever performance requirements are really rough, you'll find lightweight, high-speed Cummins Diesels assigned the hardest jobs. Every Cummins Diesel is built *TWICE*—assembled, run-in tested, disassembled and inspected...then, reassembled and retested. This *extra care* combines with Cummins' unique fuel system and efficient parts and service organization to minimize "down time" ...give users a maximum return on their diesel investment. See your Cummins dealer.

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TRADEMARK REG. U.S. PAT. OFF.

Diesel power by CUMMINS

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TRADE PERSONALS

A. H. Beach

R. W. McIntosh

Albert H. Beach, assistant to the treasurer, H. K. Porter Company, Inc., has been named comptroller of the Hinderliter Tool Company division in Tulsa, Oklahoma. Beach went to Tulsa from Pittsburgh, Pennsylvania, where he has been associated with the Robert Morris school of business administration in the capacity of instructor of industrial management.

Russell W. McIntosh has been named corrosion products representative of Dresser Manufacturing Division for the Western and Pacific Coast district. McIntosh has wide experience in the corrosion field, having been with Koppers Company for two and one-half years in the Tar Products Division. He also was with the Pittsburgh Coke and Chemical Company as West Coast manager of the protective coating division.

Stanley M. Metzger has joined Macco Corporation as manager of its refinery construction work. He is no newcomer to this line of work as he has been actively engaged in refinery construction for the last 22 years. Among his many assignments were plants in Palestine and France and various plants through the U. S.

S. M. Metzger

Sam Q. Dittenhoefer has been named sales engineer in the Chicago office of the Kaylo division of Owens-Illinois Glass Company. He will handle the sale of Kaylo heat insulation and insulating roof tile in the Chicago and Milwaukee areas. Dittenhoefer studied engineering at the University of Southern California and the University of California at Los Angeles.

S. Q. Dittenhoefer

R. S. (Dick) Jay has been appointed sales manager of the Findlay, Ohio, division of Gar Wood Industries, Inc. At the same time, were announced the appointments of **R. M. Steegman** to Jay's former position of assistant sales manager in charge of Buckeye equipment and **David J. Davis** assistant sales manager in charge of tractor equipment. Jay is an engineering graduate of Washington State University.

Ted J. Angel, Nordberg sales engineer, has been transferred from Milwaukee, Wisconsin, to the company's St. Louis, Missouri office. At this new post, Angel will assume the position of district manager of the company's central territory. In 1937, while attending Marquette University, he began his association with Nordberg as a co-op student assigned to test and erection engineering.

T. J. Angel

Stuart F. Atsatt, a Stanford graduate in mechanical engineering, has been added to the sales engineering staff of Enterprise Engine and Machinery Company. Following service with the Navy, Atsatt became a diesel test engineer and for the past four years a diesel project engineer for Enterprise. He was a LST chief engineer (Lieutenant) in the Navy.

S. F. Atsatt

B. J. A. Sturrock has been appointed division tubular manager of The National Supply Company, Ltd., Canadian division of National Supply. Sturrock will operate out of division headquarters at Calgary, Alberta, for the sale of drill pipe, casing, tubing, and other products of the company's Spang-Chalfant division mills at Ambridge and Etna, Pennsylvania.

Neal Higgins, sales consultant for the International Harvester Company, was recently awarded a Certificate of Service by the U. S. Department of Commerce for his work as director of the construction machinery division of the National Production Authority. Higgins was one of 188 American business executives who were honored at a luncheon given by the Business Advisory Council of the Department of Commerce. All those honored had served without compensation since the Korean War began.

A. P. (Joe) Wells has recently become associated with **J. M. Defee**, representing Web Wilson Oil Tools, Inc., in West Texas and Eastern New Mexico. The new combination will be known as Defee and Wells, 109 West 9th Street (P. O. Box 98), Odessa, Texas. Wells was previously connected with Oil Well Supply Company in Illinois and the Rocky Mountains; and more recently with American Iron and Machine Company.

A. P. Wells

Kenneth H. Hannan has been elected treasurer of Union Carbide and Carbon Corporation. He joined the law department of the corporation in 1936 upon graduation from Yale Law School, and became secretary and assistant treasurer of the corporation in 1949.

Morse G. Dial has been elected president of Union Carbide succeeding **Fred H. Haggerson**, who will continue as chairman of the board. Dial, a graduate of Cornell University, was elected executive vice president of Union Carbide in 1951.

Walter E. Remmers was named vice president — alloys division, Union Carbide. Remmers joined Union Carbide in 1936. He has been president of Electro Metallurgical Company since 1948, and president of United States Vanadium since 1950. Both companies are divisions of Union Carbide and Carbon.

T. L. "Tom" Fontaine, Jr., has been elected vice president and district manager of sales for the Southwest Texas division of Atlas Engineering Works, sales agents for Beaumont Iron Works of Beaumont. His headquarters will be at 1406 Jefferson Avenue, Houston, Texas. Fontaine has been associated with Atlas Works since 1949.

T. L. Fontaine, Jr.

O. W. "Ox" Morgan has been named as general sales manager for Red Devil products, Oil Well Manufacturing Corporation. Morgan joins "Red Devil" after 15 years with Byron Jackson Company. He is a member of Nomads, a charter member of the Petroleum Production Pioneers, and a member of API. He majored in engineering at Stanford University. He will be assisted by **Carroll Baker** at the home office.

O. W. Morgan

J. M. Bridges

W. G. Slife

James M. Bridges has been named South American representative of the Cardwell Manufacturing Company, Inc. Bridges completed his education with an ME degree from Texas A&M in 1940. He was with Buda Company from 1940 until joining Cardwell in February of this year.

Wayne G. Slife has been appointed as sales engineer in the Dallas, Texas office of the heavy machinery division Nordberg Manufacturing Company. Slife attended the University of Illinois and in 1942 enlisted in the United States Army Air Corps. He joined Nordberg Manufacturing in April of this year.

Harry P. Broom has been named vice president in charge of the Ralph M. Parsons Company's New York office. Broom has been associated with E. B. Badger and Sons Company and its successor, Stone and Webster Engineering Corporation. Before that he was with the Sun Oil Company.

H. P. Broom

Benjamin F. Fairless has been named chairman of the board of directors of United States Steel Corporation, upon retirement of **Irving S. Olds.** Fairless will continue to serve as president of the corporation, a position he has held since 1938. He will also continue as president of United States Steel Company, the steel operating subsidiary.

Olds will resume active practice of law with the New York law firm of White and Case, of which he has been a member since 1917.

Charles Warthen has recently been appointed district manager for sales of Atlas Engineering Works representing Beaumont Iron Works drilling and producing equipment for the West Texas area. Warthen has been associated with Atlas Engineering and Beaumont Iron Works for more than 30 years. During that time he has been active in most departments of the company.

Charles Warthen

F. P. Diener, chemical engineer of Universal Atlas Cement Company, has been appointed director of tests and research. He succeeds **George L. Lindsay,** director of tests and research, deceased. Diener was graduated from Lehigh University in 1920 with the degree of chemical engineer.

Leo F. Thompson has been named director of Industrial Relations, The Lunkenheimer Company. Thompson served as director of industrial relations of Parke, Davis and Company, Detroit, prior to his joining the Lunkenheimer organization.

L. F. Thompson

Nelson A. Howard, Jr., has been named exclusive West Coast and Rocky Mountain area representative of the Alox Corporation of Niagara Falls, New York. This company has for many years manufactured oxygenated hydrocarbons of petroleum derivation.

N. A. Howard, Jr.

Stanley M. Hunter has resigned as vice president and director of American Hoist and Derrick Company, St. Paul, Minnesota. Hunter joined the sales department of American Hoist and Derrick in 1936, progressing to general manager of sales, vice president of sales, and director in 1945 and executive vice president in 1949. Prior to association with American Hoist and Derrick, Hunter was with the Novo Engine Company. He resigned in 1936, as general sales manager to join American Hoist.

Anthony J. Allen recently joined the Wall Colmonoy Corporation as Eastern sales manager with headquarters in New York. Allen will be in charge of sales on the Eastern Seaboard. Allen is a graduate of Boston University and Armour Institute of Technology.

A. J. Allen

Dennis J. O'Leary, following several years of diesel field work in the Middle West with Cooper-Bessemer, becomes a sales engineer for Enterprise Engine and Machinery Company, with offices in San Francisco. O'Leary is a graduate mechanical engineer.

D. J. O'Leary

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MILLIONS OF DOLLARS ARE LOST ANNUALLY

And your plant is *not* immune. Corrosion may attack in many ways...

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   ... may be ruined by constant attack of acids, alkalies, fumes, chemicals, moisture, gases and weathering.
2. **Your Valuable Products**
   ... are subject to contamination and loss whenever they are in contact with corroded surfaces.
3. **Expensive Shutdowns**
   ... and loss of production with costly man-hours for repairs may be incurred unnecessarily.
4. **Your Profits**
   Ruined equipment, contaminated products, the loss of production and repair expense caused by shutdowns mean only one thing ... reduction in *your* profits!

RIGHT NOW... you should investigate the economies of using Amercoat; a *line* of coatings built to protect against *specific* industrial corrosion hazards.

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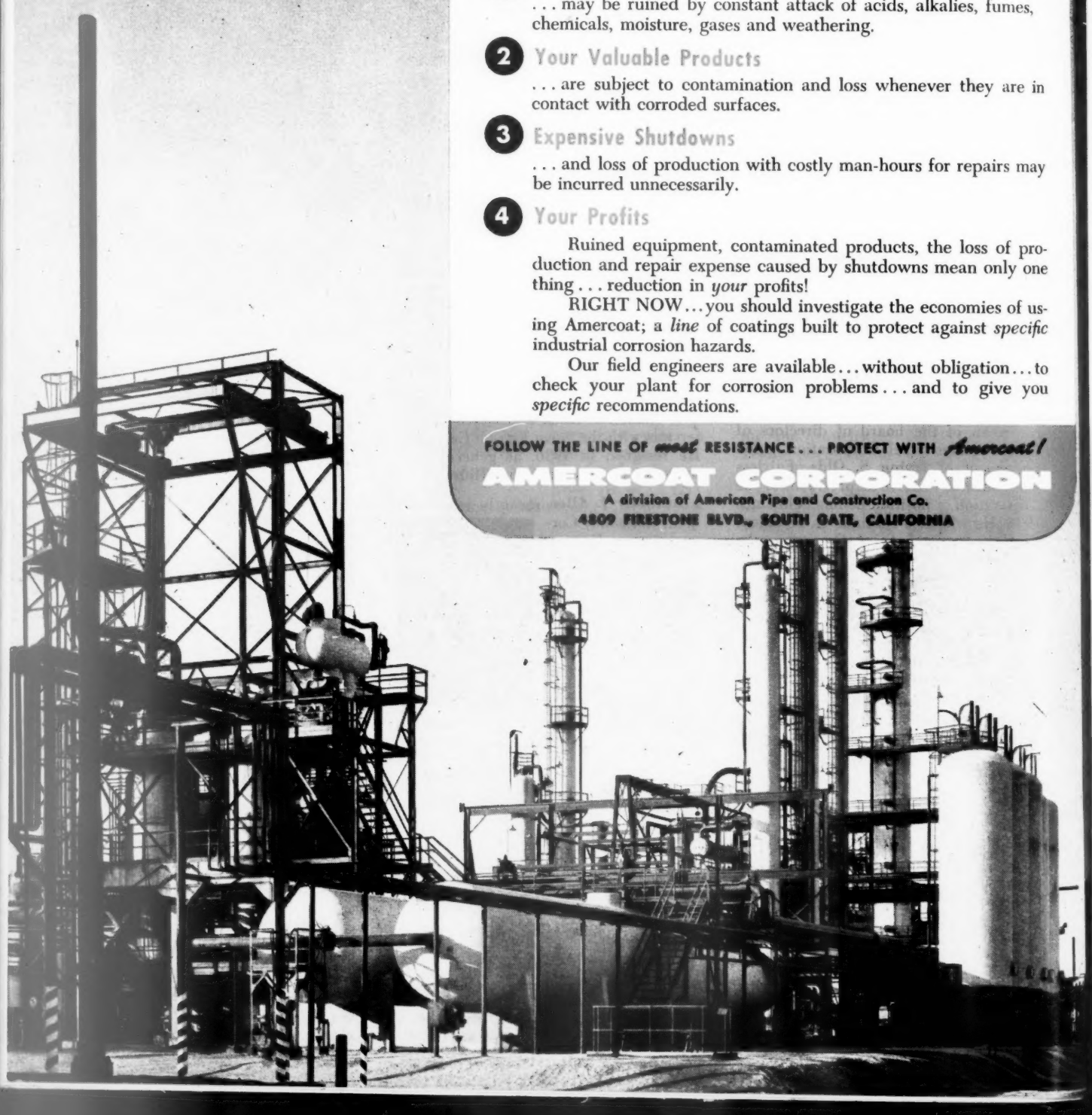


E. L. Wynne

B. S. Truett

T. G. Garwood

L. M. Wilhoit

K. W. Robbins

D. F. Taylor

Bertram S. Truett has been recently appointed district sales manager, San Francisco, and **Edward L. Wynne,** sales representative in the Chicago, Illinois, sales territory of American Meter Company. Truett joined American Meter Company, Inc., in 1937. Wynne who has been with American Meter since May of 1951, will cover the states of Iowa and Nebraska as sales engineer under the Chicago sales headquarters.

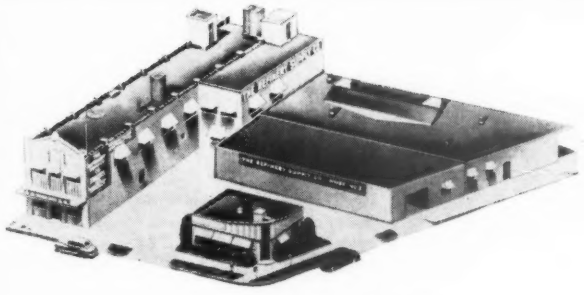
H. H. Hippler has been named assistant director, sales and advertising, Gar Wood Industries, Inc. **R. F. Whitworth,** formerly sales manager, national accounts, has been named to succeed Hippler as manager of Gar Wood's branch division. **Ross Miller,** former manager of Gar Wood's factory branch in Chicago, has been named to the position of vice president and general manager of National Lift Company, Waukesha, Wisconsin, which is a subsidiary of Gar Wood Industries.

Turner G. Garwood has been appointed sales manager for Otis Pressure Control with headquarters at the home office in Dallas. Garwood's previous assignment was in Otis' Houston office as senior engineering consultant for the Gulf Coast area. **Donald F. Taylor has** been promoted to manager of its special service department. He is an engineering consultant for Otis. **K. W. Robbins,** formerly chief corrosion analysis engineer in the calipering department of Otis Pressure Control's Houston office, has been transferred to Dallas as an engineering consultant. He will travel the northern and western parts of the Mid-Continent.

Lowell M. Wilhoit has been named production manager of Otis Engineering Corporation, manufacturing affiliate of Otis Pressure. Wilhoit was general sales manager for the pressure control company prior to his assignment to the engineering post. He has been with Otis for more than 17 years.

W. L. Klatt is now the Denver, Colorado, district manager of Pacific Coast Borax Company. Division of Borax Consolidated, Ltd. This is the first district sales office to be established by the division. Klatt has been associated with the Pacific Coast Borax Company since 1947, the last two and a half years as assistant manager of the weed control division. **J. R. Parke** has become the weed control division's Philadelphia representative. He was formerly associated with the company's package division.

Henry T. Sulcer, general manager of the Graver Water Conditioning Company, was recently elected a vice president of the parent Graver Tank and Manufacturing Company, Inc. Sulcer has directed the activities of Graver Water Conditioning since its establishment in separate headquarters in New York. He had served earlier as general auditor for all divisions of Graver.



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R. S. Moisture Tester
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R. S. Streamlined Hydrometers
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▸ **J. C. Baseheart** has been named general sales manager of the engine division of The Buda Company. Baseheart, who now has headquarters at Harvey, Illinois, is responsible for all wholesale and retail sales of Buda engines and generators. Associated with The Buda Company for 26 years, Baseheart was transferred to the Harvey office in 1951 as sales manager after 11 years as president of Buda Engine and Equipment.

J. C. Baseheart

▸ **Andrew G. "Tag" Colgin** has been named as sales representative in the East Texas and Mississippi oil fields for the New York Belting and Packing Company. He will make his headquarters in Shreveport, Louisiana, and will handle the N. Y. Belting and Packing line of conveyor and elevator belting, and other industrial rubber products. Colgin is a graduate of Louisiana State University.

▸ **F. J. (Buddy) Hebert** has been named Mission Manufacturing Company sales representative in the Corpus Christi area. Prior to joining the Mission organization, Hebert was associated with Wilson Supply Company.

▸ **E. L. "Ed" Lindsey** has been appointed Los Angeles branch manager for the pump division, Byron Jackson Company. Lindsey graduated from the University of Oklahoma in 1942. He took an additional two-year course at the Spartan School of Aeronautics at Tulsa, Oklahoma, and became affiliated with Byron Jackson Company in 1944, with the position of sales engineer at the House, Texas, branch of the company.

E. L. Lindsey

▸ **Otis R. Carpenter** of the Barberton, Ohio, works of The Babcock & Wilcox Company has been named executive assistant of the company. A graduate of Allegheny College, with the master's degree in physics from the Case Institute of Applied Science, Carpenter began work with the B&W Laboratory at Barberton in 1933.

▸ **Ben F. Stiba** has been appointed district sales representative for the Baroid Sales Division, National Lead Company. A graduate of Southwest Texas State College, Stiba joined the Baroid Sales division in 1948 as a field service engineer in the Gulf Coast division.

B. F. Stiba

▸ **Jack H. Hancock,** Orbit Valve Company of Tulsa, is being transferred to Casper, Wyoming, as field representative in the Rocky Mountain area. Hancock previously has been stationed at Chickasha, Oklahoma. **Claude W. Brown,** Orbit representative in Kansas with headquarters at Great Bend is transferring to Chickasha, Oklahoma, where he will take over Hancock's territory. Brown has been on the Orbitt sales staff since October 1947.

In the Rocky Mountain area, **LeRoy Mitchell,** distributor, has represented the company since 1947, and will continue along with Hancock.

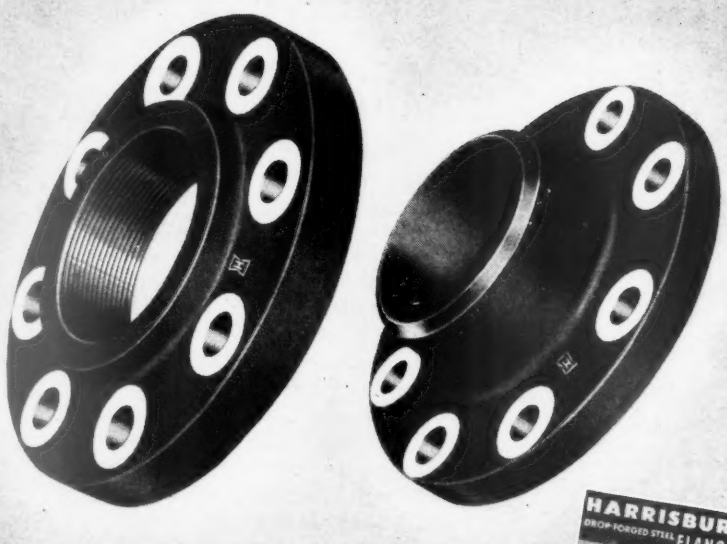
James P. ("Jim") Bowling has been selected as city salesman for Houston, Texas. Bowling was formerly South Texas representative for Rector Well Equipment Company.

▸ **James E. Emrick** has been named representative for the W-K-M Company, in the Rocky Mountain district. Emrick's headquarters, the James E. Emrick Company, is situated at 507 Bryan Stock Trail, P. O. Box 1811, Casper, Wyoming. W-K-M makes valves.

James E. Emrick

the character of the manufacturer shows in the product

Harrisburg Drop-Forged Steel Pipe Flanges are manufactured to A.S.A. Standards. Accuracy in machining produces threads that are virtually perfect in height, angle, taper, and gauging...the result of Harrisburg's 99 years of manufacturing experience.



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99 Years in Pennsylvania's Capital

Harrisburg Steel CORPORATION

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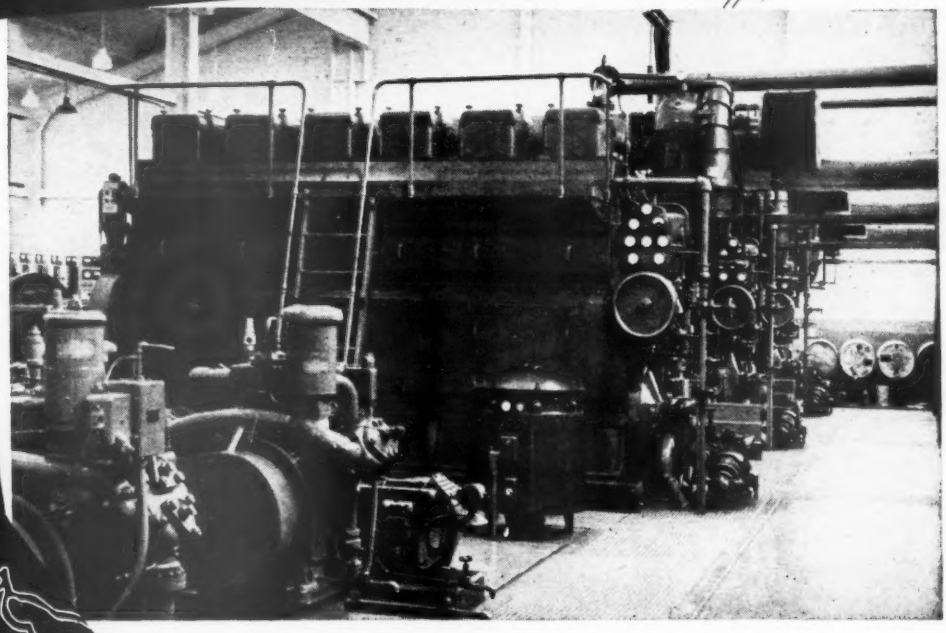
A copy of the Harrisburg Flange Catalog will be mailed, together with prices, upon request.

How "TAPLINE" is powered to bring oil across SAUDI ARABIA



Some of the 40 Worthington Supercharged Diesels installed at five stations along Tapline, operated by the Trans-Arabian Pipeline Co. Other Worthington equipment on this project includes centrifugal refrigeration compressors for air conditioning.

Worthington Diesel Engines Selected In The Largest Single Peacetime Diesel Contract Ever Awarded

Worthington Diesels were the choice for "Tapline", the huge, recently completed engineering project that is carrying oil from the oil-rich Persian Gulf area across the Saudi Arabian Desert to the Mediterranean — bringing a vital commodity 3,500 miles and 10 days nearer to European markets.

Fueled by crude oil bled from the line, 40 Worthington Diesels, at five stations along the 1068-mile system, are an unfailing source of economical, trouble-free power. Their services include pumping oil through the line (over 13 million gallons daily), generating power for 10 centrifugal compressors used for air conditioning the maintenance quarters, for pumping tremendous quantities of water needed at each station, and for lighting the communities at the stations — each of which has electrical requirements equal to an American town of 7,000 population.

Everywhere In The World . . .

Worthington Diesels on pipeline duty and in many other services are proving that this company's pioneering in Diesel building and development pays off in better, lower-cost engine performance.

Write to Worthington Corporation, formerly Worthington Pump and Machinery Corporation, Engine Division, Buffalo, N. Y.

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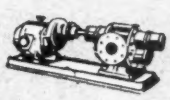
Diesel engines, 150 to 3,520 hp . . . gas engines, 175 to 3,520 hp . . . dual fuel engines, 225 to 3,290 hp.

WORTHINGTON-BUILT AUXILIARIES

Balanced Angle Compressors



Oil Transfer Pumps

Cooling Water Circulating Pumps

Evaporative Type Engine Water Cooler

Robert J. La Fortune has been named representative in the Oklahoma, Arkansas, and Colorado territory for Reilly Tar & Chemical Corporation. He was trained in petroleum engineering for two years at the University of Tulsa and took his B.S. at Purdue.

R. J. La Fortune

Dale L. Bunday has joined the General Electric electronics division as a district sales manager for communication equipment. Bunday's headquarters will be in Oklahoma City. He will be responsible for sale of G-E communication equipment in Oklahoma, Arkansas, New Mexico, and West Texas. He is a graduate of South Dakota A & M.

R. A. ("Bob") Scott has been named service representative in the West Texas area for Technical Oil Tool Corporation. Scott, who had previous experience in drilling and production, will be stationed at Odessa, Texas, where he will work under the direction of **Ed Siever**, West Texas division manager.

R. A. Scott

J. B. Okeson

T. C. Williams

J. B. Okeson has been named vice president in charge of sales of The Refinery Supply Company. **T. C. Williams** has been named vice president in charge of operations. Both of these men have been with the company for more than 25 years.

W. W. Coleman has been named chairman of the board of directors of Bucyrus-Erie Company. Other officers named are: N. R. Knox, vice chairman; W. L. Litle, president; P. H. Birckhead, vice president; R. W. Newberry, vice president; C. K. Charlton, vice president; P. S. Stevens, vice president; M. T. Smith, vice president; L. S. Cline, secretary; and F. C. Weiblen, treasurer.

D. P. Eells retired as a director after 45 years of association with the company and the board elected **P. H. Birckhead** to fill the vacancy. Birckhead, vice president in charge of sales, has been with the company for 36 years and vice president since 1943.

R. B. Barnhill, formerly manager of automotive and mobile sales, has been named commercial sales manager for the radio communications division of Bendix Aviation Corporation. In his new capacity, Barnhill assumes responsibility for the sales of the entire line of products manufactured by the division for commercial markets. Bendix is a leading manufacturer of aviation communication and navigation equipment, railroad radio, mobile communication systems, and custom automobile radios, and other equipment.

K. C. Winston has been assigned to Casper, Wyoming, as representative for Bethlehem Steel Company. He will work in cooperation with the company's wire rope distributors throughout the extensive Rocky Mountain territory.

H. Raymond Hogaboom, for many years engaged in oil field and power transmission work, has been appointed new district manager of Enterprise Engine and Machinery Company in Los Angeles, California. Hogaboom replaces **P. B. Erwin**, who has retired from active business life. Hogaboom is a graduate of the University of California.

H. R. Hogaboom

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15 YEARS CONTINUOUS OPERATION WITHOUT OIL CHANGE IN DIESEL AND GAS ENGINES—NEGLIGIBLE PISTON AND CYLINDER WEAR.

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IN CANADA—UPTON-BRADEEN-JAMES, LTD., 990 BAY STREET, TORONTO, 3464 PARK AVE., MONTREAL

W. D. Adams has been named West Texas zone manager for Tube-Kote, Inc., it has been announced by L. E. Heinen, president of the company. Adams is a graduate petroleum engineer of Texas A&M College with prior oil field experience.

W. D. Adams

Raymond C. West and **George F. Bright** have been assigned to new district manager positions. West becomes Gulf Coast district manager with headquarters in Houston, Texas, while Bright is made manager of the Mid-Continent district with headquarters in Tulsa, Oklahoma.

Harry E. Boynton has been named district manager for Tube Turns of Canada, Ltd., in Western Canada. Boynton will make his headquarters in Edmonton, Alberta. Boynton obtained his degree in mining engineering at the University of Toronto. Before joining Tube Turns of Canada, 1951, he was chief engineer of the Eldorado Mining and Refining, Ltd.

H. E. Boynton

George V. Slottman has been named a vice president of Air Reduction Company, Inc. He has been the company's director of research and engineering since 1949, and will continue in charge of that activity.

A native New Yorker, Slottman was graduated from Massachusetts Institute of Technology in 1925.

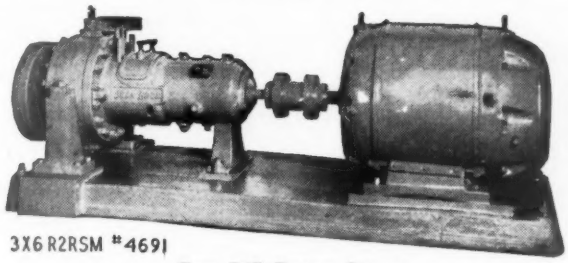
Donald G. Fink will join Philco Corporation on June 1 as co-director of research-operations. Fink has been associated with *Electronics* since 1934 and its editor since 1946. He is a graduate of Massachusetts Institute of Technology and Columbia University and has a BS and MS degree.

B. K. Smith has been named store manager for Bethlehem Supply Company's new Midland, Texas, store. Smith formerly was store manager at the Snyder, Texas store and has had considerable experience in the operation of a supply store in a very active area. The Midland store will be under the supervision of **W. A. LaRew**, district manager of the West Texas and New Mexico district.

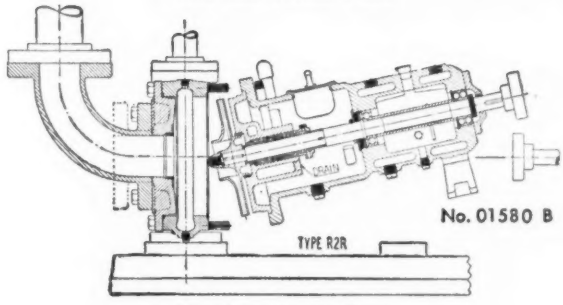
B. K. Smith

DEAN BROTHERS PUMPS INC.

Type R2R Centrifugal Process Pumps



Type R2R Process Pump



Type R2R Process Pump

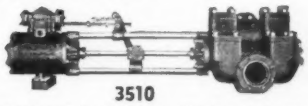
DISASSEMBLY: The Type R2R process pumps can be disassembled without disconnecting the suction and discharge piping. By first removing the spacer from the spacer type coupling, and unbolting the casing from the cradle the entire cradle and complete rotating element can be removed without disturbing the suction and discharge piping.

OPERATING RANGE: Type R2R, Heavy duty, process pumps are available in eighteen different sizes, enabling our engineers to furnish units specially designed and constructed for the particular work to be performed.
Capacities: 50 to 2000 Gallons per minute. Heads: Up to 400'. Speeds: 900 RPM to 4000 RPM.

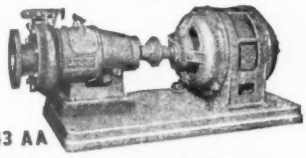
BUILDERS OF OUTSTANDING PUMPS SINCE 1869

CENTRIFUGAL and RECIPROCATING PUMPS

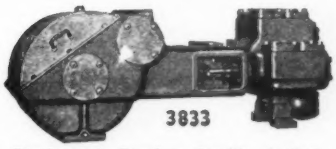
Close Coupled Centrifugal Pump



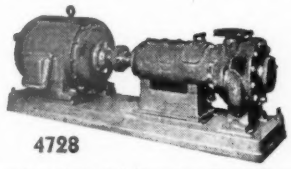
Horizontal, Single Style, Double Acting, Piston Type, Close Clearance Pump. Designed to handle volatile liquids



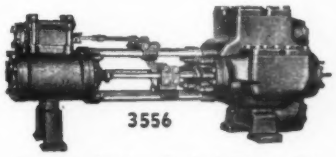
Pedestal Mounted Centrifugal Pump



Horizontal, Duplex, Double Acting, Side Pot, Piston Type, Oil Bath Power Pump



Double Pedestal Bearing Centrifugal Pump



Durable Duplex Packed Piston Pattern Steam Pump, Side Pot Type

ESTABLISHED 1869

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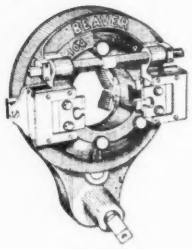
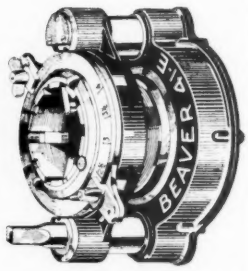
BEAVER 41-E THREADER 104 CUTTER

Beaver No. 104 Geared Square-end Knife Cutter cuts off square and clean without burr. Knives feed automatically — with safety guide ahead of cutting edge to prevent knife breakage. The No. 104 is ideal for cutting, grooving or beveling pipe. Furnished complete with operating ratchet.



No. 104

Beaver No. 41-E Geared Threader is fully adjustable for undersize and oversize threads of uniform length. Threads all sizes, 2½" to 4", with one set of dies! Fully-enclosed gear case! Furnished complete with operating ratchet.



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BOOKS

Theoretical Petrology, *by Tom F. W. Barth. Published by John Wiley and Sons, 440 Fourth Avenue, New York 16, N. Y. Price, $6.50. Pages, 369.*

"Theoretical Petrology" gives the present status of our knowledge in all fields of petrology—covering igneous, sedimentary, and metamorphic rocks. An exact and comprehensive scientific study of the rock-making processes, and an interpretation and synthesis of the existing quantitative data—the field data from all over the world, the experimental data from geophysical and geochemical data from laboratories, and the theoretical data of the research workers in geology, chemistry, and physics.

From these data, Dr. Barth sketches the cyclic history of the rock masses of the earth's crust: Their origin, evolution, transfiguration, destruction, and redevelopment.

Factory Planning and Plant Layout, *by William Grant Ireson. Published by Prentice-Hall, Inc., 70 Fifth Avenue, New York 11, N. Y. Price, $7.35. Pages, 172.*

The aim of this textbook is to present factory planning as just what it is: An engineering problem that can be solved by the systematic collection of data, logical analysis of that data, and the application of imagination and initiative. The book covers the methods of analysis in factory planning, principles of layout and departmentalization, methods and procedures, errors in layout, materials handling, factory services, and planning for personnel facilities. An extensive appendices is added at the end of the book, and illustrations of the various problems and solutions are carried throughout the book.

Plane Table Mapping, *by Julian W. Low. Published by Harper and Brothers, 49 East 33rd Street, New York 16, N. Y. Price, $5. Pages, 360.*

This field manual has been prepared for the purpose of instructing students in the plane table methods by which a survey is carried out from its inception to its logical end, namely, a finished map. The use of newer techniques has created a still greater need for the plane table, either as an adjunct to the method being employed or as a means of setting up a reliable graphic framework of control on the ground. The book has two objectives: First, to place in the hands of teachers and students an elementary text, and second, to assemble a large number of methods adaptable to certain types of mapping.

Performance of Lubricating Oils, *by H. H. Zuidema. Published by Reinhold Publishing Company, 330 West 42nd Street, New York, N. Y. Price, $5. Pages, 171.*

This new book summarizes and evaluates the wealth of data on the performance characteristics of lubricating oils under various conditions. The subject is approached from the standpoint of performance rather than specific application. Chapters are devoted to lubrication process, flow characteristics, sludge and lacquer deposition, emulsification and foaming, with ample reference to viscosity, pour point and extreme pressure lubrication. Charts, tables, and illustrations supplement the text.

A Bibliographical Survey of Flow Through Orifices and Parallel Throated Nozzles, *by T. H. Redding. Published by Chapman and Hall, Thirty-Seven Essex Street, London W. C. 2, England. Price, 32 s 6 d. Pages, 197.*

All aspects of flow through orifices and parallel-throated nozzles have been reviewed in this book, but particular emphasis has been given to use of these devices for measuring rate of flow. Not only does the work contain pure bibliography, but also a valuable technical introductory and an appendix defining some 92 terms used in flow metering practice. The Bibliography covers the literature of the subject from the year 1832, and is classified by subjects comprising over 600 entries under 16 subject headings. In addition there is an author classified index referring to the subject entries. Abstracts are given in all cases.

Oil Shale and Cannel Coal, Vol. 2. *Published by the Institute of Petroleum, 26 Portland Place, London, W. 1. Price, 63s. Pages, 327.*

In 1938, the Institute of Petroleum organized and held the first Oil Shale and Cannel Coal Conference and published proceedings on that conference which are regarded as a standard reference book on the subject of retortable oil-yielding materials. The Second Conference was held in 1950, and fifty papers were read and discussed. These papers and a report of the discussion form the present volume. All aspects of oil shale and shale oil are covered—mining, retorting, refining, utilization, and assay.

Welding Principles for Engineers, *by J. L. Morris. Published by Prentice-Hall, Inc., 70 Fifth Avenue, New York 11, N. Y. Price, $7.35. Pages, 504.*

This text book seeks to organize welding material appropriate for training on the college level. It is directed expressly to the engineering college group and, for this reason, contains very few of the explanations and techniques more suited to the vocational and trade groups. The book is divided into 13 chapters, of which some are: Welding metallurgy; welding processes; testing and inspection of welds; welding of commercial metals; surfacing; metal spraying; flame heat-treatment, and factors affecting welding production economy.

Testing of Measuring Equipment, *by Ralph W. Smith. Published by the National Bureau of Standards, Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. Price, $1.25. Pages, 205.*

This volume completes a series of four Handbooks of the National Bureau of Standards designed to present information relative to weights and measures regulatory activities. The present volume deals with commercial measures and measuring devices, and includes descriptions of these instruments, recommendations for testing apparatus needed for official examination, and instructions for their inspection and testing by weights and measures officials.

Fluid Flow in Pipes, *by Clifford H. McClain. Published by The Industrial Press, 148 Lafayette Street, New York 13, N. Y. Price, $3. Pages, 123.*

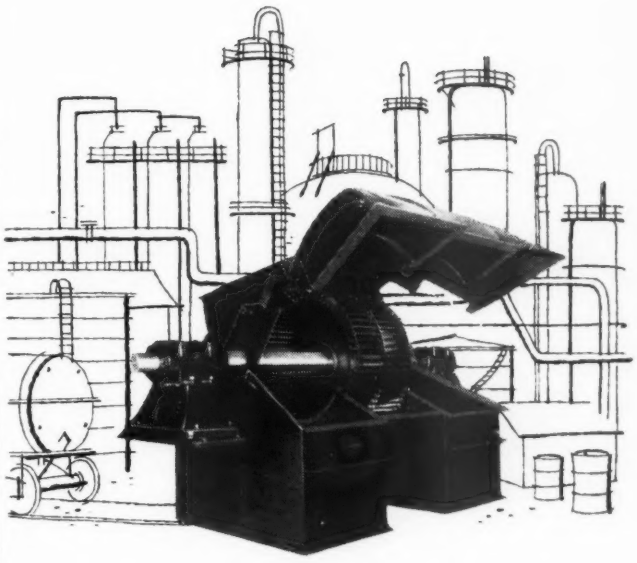
An ideal introduction or refresher this book covers the mechanics and dimensions of gas and liquid flow in pipes and ducts. Fundamental physical processes involved are explained in simple language, and the dimensions used in various systems of calculation are clarified. Properties of fluids affecting flow are discussed with illustrations of the over-all influence of each. Theory, measurement, and dimensions of viscosity are carefully explained for the neophyte, while derivations calculations are included for those who wish to explore the subject more deeply.

Production Control, *Paul D. O'Donnell. Published by Prentice-Hall, Inc., 70 Fifth Avenue, New York 11, N. Y. Price $6.35. Pages, 291.*

This new text covers production control from production forecasting to cost control. Numerous case histories clarify the text matter. The book is designed for the case method of teaching, the descriptive matter being as self-explanatory as possible. Chapters on: Production forecasting, product development, plant layout materials handling, control of materials, routing scheduling, dispatching, follow-up, quality control, and cost control, are included.

Communication of Technical Information, *Robert M. Dederich. Published by Chemonomics, Inc., 400 Madison Ave., New York 17, N. Y. Price, $5. Pages, 116.*

This handbook concerns itself with the fundamental principles of communication. It is not an outline of report writing nor of grammar, spelling, and punctuation. The author views the art of communication as the nerve center of an organization, with the technical man working not only at his specialty, but transmitting his ideas to other people. The stress is on logic and thinking which must underlie communication of technical information. Therefore the book deals not only with the written report, but with inter-organization memos, progress statements, and the subject of oral presentation.



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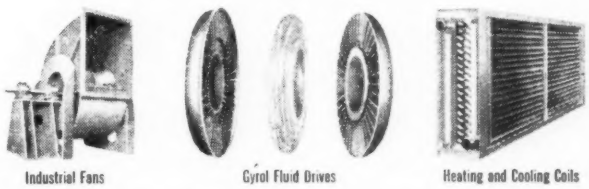

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New Machinery and Supplies

Use reply card to procure promptly complete information and prices of products described here in brief.

Circle corresponding letter or letters on reply card.

(A) PAINT FINISHES

The Jones-Blair Paint Company is announcing a new line of oil field finishes that has been engineered to fit the particular needs of the southwestern oil industry and to meet all requirements of the recently adopted standard safety color code for drilling rigs. The finishes also match most standard company colors. Something new, introduced with this line are the color cards which carry, in detail and full color, the Safety Color Code for Drilling Rigs adopted January 6 by the Safety Committee of the American Association of Oilwell Drilling Contractors.

Circle letter (A) on reply card.

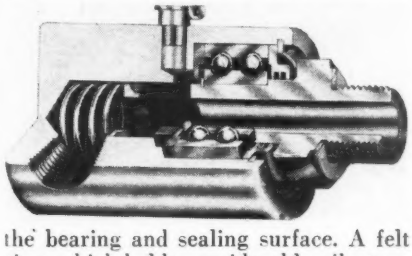
(B) ROLLER BEARINGS

The Roller Bearing Company of America has announced the introduction of a completely new type bearing—Pitchlign. Pitchlign rollers cannot cock or skew, the company claims. They are kept in perfect alignment by cage contact at their pitch line. This reduces stress and tangential forces to an absolute minimum. Overall efficiency of the cage is not affected by accumulated tolerance and wear of load-carrying surfaces, as it is supported by the two integral flanges of the heavy outer race. They can be mounted in any plane—horizontally or vertically.

Circle letter (B) on reply card.

(C) ROTO-COUPLING

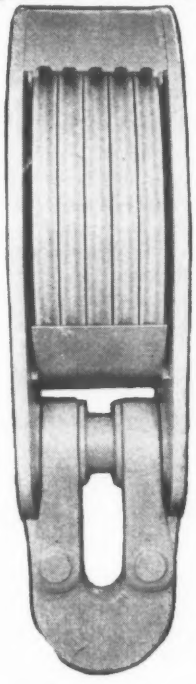
The Wichita Falls Foundry and Machine Company, Inc., has developed a new Roto-coupling, which it states, has been perfected to the extent that it is impossible for grit and sand to enter



the bearing and sealing surface. A felt ring, which holds considerable oil, stops these abrasives and also keeps the sealing surface lubricated much longer than Roto-couplings that do not have such a felt oil ring. The "O" ring seal also permits the carbon ring to move forward freely as wear occurs.

Circle letter (C) on reply card.

(D) TRAVELING BLOCK



The new Type "PN" traveling block of Beaumont Iron Works Company is of the narrow type with the center to center distance between sheaves 3¾ in. The narrow width allows the use of this block on deep holes where pipe space is at a premium. Sheave diameter of 52-in. reduces bending stresses on the wire line. Sheaves are grooved to API dimensions. Each sheave is mounted on a radial roller bearing and is separated and retained in position by a row of sperical ball bearings.

Circle letter (D) on reply card.

(E) PUMPS

Chain Belt Company of Milwaukee announces the production of the new 2-in. Rex general purpose speed-primer pump. The light weight self-priming centrifugal has a semi-steel impeller, and an adjustable peeler of high carbon steel, replaceable wearing plate and a leak-proof seal. Large cover plates are easy to remove, and makes wearing parts completely accessible for quick adjustment when necessary.

Circle letter (E) on reply card.

(F) CHAIN FASTENER

Use of Rollpins, new roller chain fasteners, has been announced by Morse Chain Company, Division of Borg-Warner Industries. The Rollpins will be available on most of the larger pitches of both standard and heavy-series Morse Roller Chains. The Rollpin is a chamfered-end, slotted steel cylinder that compresses easily into a pin hole smaller than its own diameter, expands and locks in place until deliberately removed by hammer and punch. It may be re-used almost indefinitely.

Circle letter (F) on reply card.

(G) DRILLING

A new model portable drilling rig, known as the FAILING "CFD-1" Holemaster, is being announced by the George E. Failing Supply Company of Enid, Oklahoma. The "CFD-1" Holemaster is a self contained unit and it is designed especially for fast shot hole drilling. The new drill has a rated capacity for holes to a depth of 1000 ft using 2⅜-in. drillpipe.

Circle letter (G) on reply card.

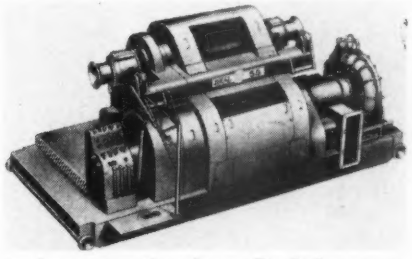
(H) SHAFT SEALS

The use of standard mechanical shaft seals, instead of conventional stuffing boxes, is the outstanding feature of a new line of horizontal, split-case, general service pumps recently announced by Peerless Pump Division, Food Machinery and Chemical Corporation. This line of pumps, designated as the Peerless Type AS, is available in discharge sizes from 1½ through 4 in. Capacity range is up to 750 gpm and head range is up to 230 ft. General application is for pumping water and clear liquids up to 200 F where no solids are in suspension.

Circle letter (H) on reply card.

(I) CONSOLIDATED RIG

A new consolidated rig of sectionalized construction, for use with two torque converter equipped engines having a combined input rating of 550 hp, has been announced by The National Supply Company. Known as the Ideal Type 55 consolidated rig, it will normally be used for drilling in the 5000 to 7500-ft depth range. The sectional-

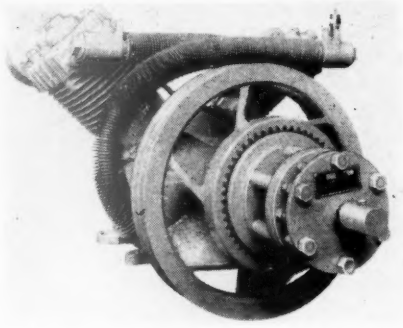


ized construction has afforded a number of design advantages, among them being the use of a large spooling drum, 22 in. in diameter and 49 in. long, grooved for use with 1⅛ in. wire line. This drum capacity permits usual hoisting operations with less than three full layers of line on the drum.

Circle letter (I) on reply card.

(J) AIR COMPRESSOR CLUTCH

A new and completely automatic air compressor clutch that will start the compressor at any desired minimum pressure without requiring the operator's attention, has been announced by the Wichita Falls Foundry and Machinery Company. Strong springs provide simple, positive engagement. Air pressure acts on a diaphragm to disengage clutch when maximum pressure is reached. The maximum and minimum pressure is set on a pilot valve.



Circle letter (J) on reply card.

(K) WATER MEASUREMENT

Beckman Instruments, Inc., has recently developed a new type of instrument known as the Beckman Aquameter, to determine the water content of products completely automatically. The instrument uses the Karl Fischer technique, thus eliminating errors caused by temperature effects, oxidation, and decomposition such as are introduced by oven-drying procedures. Basically, the instrument consists of an electrically controlled titrating unit into which the sample is introduced.

Circle letter (K) on reply card.

(L) BULK PLANT METERS

A new bulk plant meter, the Rotocycle 6 BLX, has recently been developed by Rockwell Manufacturing Company for liquid accounting of inventory withdrawals of aviation gasoline. This 6-in. rotary, positive displacement meter may also be used extensively on loading racks for measurement of refined petroleum and in chemical plants, lubricating oil plants, and industrial proportioning operations.

Circle letter (L) on reply card.

(M) CORROSION CONTROL

A new product called Tintallium, proving itself extremely effective in corrosion control and rugged lubrication has been developed by American Sand-Banum, Inc. Tinallium Pro-Tex-It, trade name, is in the form of a non-drying black paste. It is adaptable for porous and non-porous materials including all metals, woods, and concrete mixes for preservation against weathering conditions, acids, fumes, chemicals, etc. It will not stain water or other liquids, and withstands contraction and expansion.

Circle letter (M) on reply card.

(N) REGULATING VALVE

A new double seated diaphragm regulating valve for use with control instruments has just been announced by Leslie Company. The new valve, "Class DV" has been developed to meet all the features required.

Among the principal features of the new valve "Class DV" is its "flow-line" contoured body. This has been designed to provide ISA standard face-to-face dimensions with the highest capacity, lowest turbulence and body pressure drop. The large bowl construction provides smoothly contoured, full area passages, the company states.

Circle letter (N) on reply card.

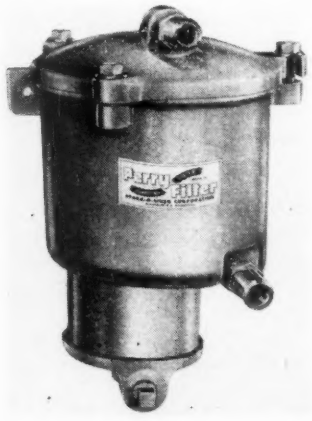
(O) FENCE COATER

The Rust-Oleum Corporation has developed a new long-nap, lambs-wool roller for use in coating wire fences. The roller is dipped into the container of material (usually 5-gal containers are best), is pulled up on a flat board surface of approximately the same width as the roller to remove running surplus material. The roller is then applied to the area to be coated. Even the barbed wire on top of the fence can be rolled on, although the pipe framework and supporting arms holding the barbed wire are best done by brushing after the fence has been roll-coated.

Circle letter (O) on reply card.

(P) COOLING SYSTEM FILTER

Reduction of wet-sleeve pitting in industrial diesel cooling systems by as much as 70 per cent through application of the Perry cooling system filter, is claimed by the manufacturer, the Spark-O-Liner Corporation. Pitting, caused by galvanic action in minute areas not



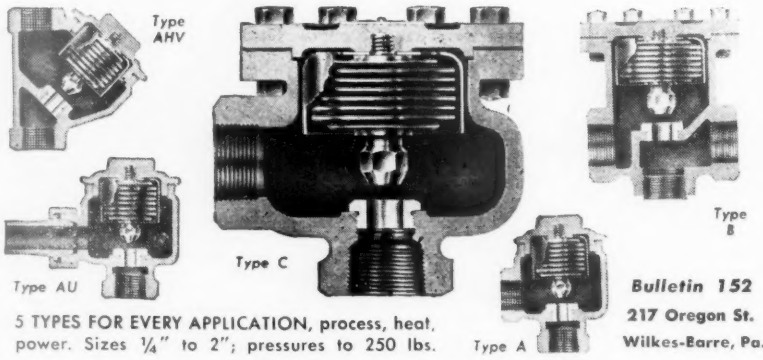
adequately protected by rust inhibitor film, is eliminated through a cathodic current generated by the filter. This current, while small, is sufficient to induce the forces of corrosion to attack "sacrificial" corrosion-resistor plates in the filter, which are more vulnerable than metals in the cooling system. Rusting, pitting, hardness deposits, acid or alkaline conditions, and insoluable impurities, are controlled by a combination of mechanical filtration, chemical additives, and electro-chemical protection.

Circle letter (P) on reply card.

Nicholson Steam Traps

CUT HEAT-UP TIME 48%

A large processor recently reduced the heating cyles of cookers from 105 min. to 50-60 min., by substituting Nicholson thermostatic steam traps for a mechanical type. This effected a gratifying production increase of 37%. Reasons for Nicholson's faster heat transfer: operate on lowest temperature differential; 2 to 6 times average drainage capacity; maximum air venting. To learn why an increasing number of leading plants are standardizing on Nicholson thermostatic traps send for our catalog.



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TRAPS · VALVES · FLOATS

(Q) FLOW CONTROL

A new dual flow control has been introduced by Oil Center Tool Company as a companion unit to its JE flow control. This new unit is the only compact dual assembly on the market so designed that by simply changing the flow bean cage nipples the operator can use positive choke beans of any manufacturer. The dual flow control replaces six different fittings: Cross, two wing valves, two choke assemblies (either adjustable or positive), and bottom hole tester top assembly. With this new flow control the operator may switch the flow from one sized choke to another without closing in the well and thus changing any of the well's characteristics.

Circle letter (Q) on reply card.

(R) PIPE INSULATION

Dual temperature pipe insulation, a new scientifically designed Fiberglas insulation for pipe lines operating at low temperatures or at alternate cycles of high and low temperatures, is now being offered by Owens-Corning Fiberglas Corporation. This dual temperature pipe insulation is made of fibrous glass bonded with a thermosetting binder. A vapor barrier, composed of laminations of asphalted kraft paper and aluminum foil adhered to the Fiberglas insulation with a bituminous adhesive, provides effective condensation control on cold lines passing through warmer temperatures and permits exceptionally economical operation of such pipes, according to the manufacturer.

Circle letter (R) on reply card.

(S) MOBILE LUBRICATION SERVICE

A new type of valve lubrication service for the petroleum and chemical industry has been introduced by the Desco Service Company. The new Desco service takes over the responsibility of positive and proper lubrication and adjustment of all valves on the customers property. This is accomplished with a fleet of Desco trucks specially designed and equipped to serve chemical plants, refineries, xmas trees, tank batteries, gathering lines or the entire length of a pipe line.

Circle letter (S) on reply card.

Desco lubrication service.

(T) WELL SWABS

The new E-Z swab is the latest addition of Mission Manufacturing Company's list of products. Utilizing only one type of swab rubber, the Mission E-Z swab swabs wells of all depths—from the shallowest to the deepest. Oversize streamlined tube passage and extra fluid passage around the edges of the advanced-design swab rubbers cause Mission E-Z swabs to fall faster in fluid. On the down stroke when the E-Z swab rubber fins are in their normal upturned position their outside diameter is less than the inside diameter of tubing allowing the swab to fall free.

Flexibility of Mission E-Z swab rubber fins permits the swab to pass smoothly through tight spots in tubing or through paraffin bridges on both up and down strokes. When the operator attempts to pull too much fluid, the Mission E-Z swab rubber fins bend down and by-pass excess fluid.

Circle letter (T) on reply card.

(U) TITANIUM IN VALVES

Rockwell Manufacturing Company has announced that extensive research tests have shown that its Nordstrom valves can be successfully used on the vacuum services in the production of titanium. This metal, so important because of its light weight, unusual strength, and corrosion resistant qualities, is being widely used in jet airplane engine production. A large Eastern chemical company experimenting in the production of titanium discovered that in melting sponge titanium, which resembles gray coke, alteration of certain titanium properties took place because of the metal's affinity for gases.

Circle letter (U) on reply card.

(V) DEPOSIT REMOVER

Magnus Chemical Company has announced a heavy duty alkaline cleaner, Magnus 61RS, to remove deposits from valves and fittings. This cleaner has a strong alkaline cleaning action, but without fumes and is free from the hazards of caustics. Valves and fittings are loaded into an 800-gal heated tank containing an 8 oz per gallon solution of 61RS in water. This solution is kept at a rolling boil. Some fittings are thoroughly cleaned in 30 min. They are removed and processed. Others may take another 30 min.

Circle letter (V) on reply card.

(W) CENTRIFUGAL PUMPS

Rice Pump and Machine Company announces the addition of three larger sized pumps, namely the 20M, 30M, and 40M, to their line of self-priming centrifugal pumps. These pumps conform to the standard of the contractors pump bureau of the Associated General Contractors of America (AGC).

Circle letter (W) on reply card.

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TABLETS REMOVE AND PREVENT RUST AND SCALE IN ALL RADIATOR COOLING SYSTEMS

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★ COFFEE SHOP

(X) PUMPING JACK

Pelton Water Wheel Company has developed a long stroke hydraulic pumping jack with an automatic controller. On automatic time clock electric motor operation the frequency and duration of pumping periods occur at predetermined intervals without attention from operator. With the Pelton long stroke hydraulic pumping jack such automatic operation is extremely practical as the entire Pelton unit functions on a closed hydraulic circuit. The principal advantages of long stroke hydraulic pumping are: Simplicity of sucker rod pumping retained; increased oil production through Pelton long stroke, etc.

Circle letter (X) on reply card.

(Y) SPEAKING TUBE

The S and S Specialties speaking tube has been developed to afford conversation to and from any part of the derrick regardless of noise interference. The standard hook-up on the speaking tube is from "driller to monkey board to crown", but can be used in various places around the rig. The speaking tube is 1½-in. diameter flexible tubing, plastic covered to protect it from the weather. The mouth pieces are of heavy cast aluminum installed on all terminals, and the tube comes complete in heavy steel container with hinged cover and two carrying handles.

Circle letter (Y) on reply card.

(Z) ELECTRODE HOLDER

A new, lightweight, 300 amp electrode holder has just been introduced by the Tweco Products Company, known as the Model A-732 Twecotong holder. It features a lightweight, high copper alloy for maximum conductivity. Raised upper lever allows plenty of room for the operator's hand with a welding rod in the jaws. Body and tip ends of the holder are insulated with Tweco's patented "Super-Mel" insulators. Tip end insulators are interchangeable. The new A-732 Twecotong electrode holder will handle from 7/32-in. through 1/16-in. electrodes. The welding cable may be soldered or clamped mechanically to the body of the holder. Only 9¼-in. in length, the new holder makes it easy for the operator to weld in those "hard to get at" places.

Circle letter (Z) on reply card.

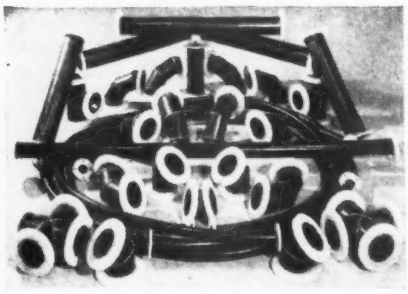
(AA) ROTARY HOSE

A new all-steel rotary hose unit designed specifically for portable rotary oil drilling rigs has been developed and successfully field-tested by Chiksan Company. The complete unit consists of a 6-ft outrigger swivel arm bracketed securely to the mast leg and extending from the standpipe away from the derrick. To this is attached a steel rotary hose incorporating ball-bearing swivel joints to permit complete flexibility and ease of operation in limited space. This in turn is connected to a drilling swivel extension that serves to increase the flexibility of the hose.

Circle letter (AA) on reply card.

(AB) PLASTIC PIPING

A new, durable but semiflexible piping highly resistant to a wide variety of solvents and unaffected by mineral acids, salts, and alkalies at tempera-



tures up to 150 F has been announced by Munray Products, Inc. It is also unaffected by temperatures as low as –50 F and retains all its properties through repeated freezing and thawing. It is free from electrolytic corrosion, the manufacturer adds. Cyclothene pipe is from high purity ingredients, and will not react with food or beverage.

Circle letter (AB) on reply card.

(AC) WELL TUBING

Recently developed self-sealing tubing joints, such as Hydril and Spangseal, open a new avenue to tubing corrosion control, Bart Manufacturing Company has reported. Patented Bart Lectro-Clad process deposits pure nickel on i. d. of tubing and on pin and box areas to effect a continuous pore-free barrier between gas or oil stream and parent steel tubing. The process offers advantages over many alloys as corrosion control is concentrated at the surface without affecting the structural characteristics of the parent steel tubing. Plant facilities are available for operation.

Circle letter (AC) on reply card.

(AD) SERVICING HOIST

Hopper Machine Works has developed a new oil well servicing works, which can be moved from job to job under its own power, provided by a six-cylinder General Motors diesel engine equipped with GM torque converter. Basically, the Hoistmobile, trade name for the equipment, is a 4-axel vehicle, 35 ft in length, with the engine mounted at the extreme rear, a double drum winch amidships, and a folding derrick at the front, over the cab.

Circle letter (AD) on reply card.

(AE) WELL HEADS

Baash-Ross Tool Company has recently announced a new line of well head equipment that incorporates a number of unique features to increase the efficiencies of modern landing and casing head operations. Known as Type "UPS" heads, this new equipment features a design in which the packing element and the slips are combined into a single *unitized* assembly that simply wraps around the casing and is held in place by inserting one bolt.

Circle letter (AE) on reply card.

(AF) CURRENT SUPPLY

A new electronic constant current supply, which provides a steady d-c source from an a-c line, has just been introduced by Weston Electrical Instrument Corporation. Designed primarily for use with potentiometer indicators, recorders and controllers, where automatic standardization is not feasible or where use of batteries is not desirable, it is also used with resistance thermometers, strain gages, or other devices requiring a constant d-c current.

The standard unit is designed for a 10 ma output at 1.4 d-c, and provides a current with a high degree of stability to within the limitation of plus or minus 1/10 of 1 per cent.

Circle letter (AF) on reply card.

(AG) EMULSION MUD

Oil Base, Inc., is now manufacturing a ready-mixed emulsion mud concentrate that will not fluoresce under ultraviolet light. It is known as OB No-Glo and has all the characteristics of an excellent oil emulsion mud. It will not foam or ferment and is not a soap, Oil Base reports. One drum of OB No-Glo (407 lb net) is added to every 5 bbl clay-water mud in the system to produce a sodium-base emulsion in proportions of about 14 per cent oil and 10 lb emulsifier to the barrel. It can be chemically treated in the normal way and converted to lime-base emulsion.

Circle letter (AG) on reply card.

(AH) DRIVING DEVICES

A new magnetic adapter and magnetic hexagon-square shank (patents pending) have been developed by J. H. Williams and Company for use only with Williams impact "Supersockets" to drive hex head hardened and self-tapping screws. A telescopic magnetic device passes within an assembled socket and contacts the screw head, retaining same within the socket opening. The Alnico magnet, imbedded in the drive member, is spring loaded to overcome air gaps and transmits its magnetism through a hardened steel tip to the head of the screw. A hexagon-square shank and an adapter are available for ¼-in. drive size tools with socket openings 1/4, 9/32, 5/16, and 3/8-in.

Circle letter (AH) on reply card.

(AI) BALL BEARINGS

Sealed ball bearings that are designed to keep dirt out—and lubricant in—and that are interchangeable with conventional non-sealed bearings, have been announced by SKF Industries, Inc. Known as SKF's Red Seal bearings, the seal is made of DuPont Fairprene, and is not affected by petroleum-base lubricants, normal operating temperatures, or aging. An exclusive design, providing effective sealing—with extremely light contact and low friction—extends the seal below the steel retaining ring, forming a flexible lip that lightly touches a smooth, uniform chamfer of the inner ring.

Circle letter (AI) on reply card.

Trade Literature

Publications will be sent free.

(AJ) CENTRIFUGAL PUMPS

Now available through Allis-Chalmers general machinery division district offices is the first in a series of a new educational service to industry in the form of three 35 mm sound filmstrips on centrifugal pumps for showing before interested groups. Titles of the three films, each with a running time of about 30 min, are "How and Why of Centrifugal Pumps," "Pump Maintenance," and "Covering All Angles."

Circle letter (AJ) on reply card.

(AK) ELECTRODE OVEN

Philip Roden Company has published its newest bulletin, DR-2, describing the DryRod electrode oven, which has been developed to protect mineral coatings against moisture absorption. The DryRod is a portable, electrically heated oven designed for better care and storage of unpacked coated electrodes at their point of use. Variable thermostatic control regulates temperatures to safe-hold any type of coated electrodes now in use.

Circle letter (AK) on reply card.

(AL) INDUCTION MOTORS

Construction features of Allis-Chalmers drip-proof and splash-proof squirrel-cage induction motors are described in a new bulletin released by the company. The bulletin relates that the drip-proof motors (Type AW) are available in all ratings in NEMA Design B, which is suitable for the majority of cage motor applications.

Circle letter (AL) on reply card.

(AM) DRILL BITS

Acme Fishing Tool Company has published a 4-page brochure illustrating its cable tool drill bits. Pictures and reading matter depict Acme equipment concisely, explaining the many features exclusive with the company. A card is enclosed, which the reader may send in for more detailed catalogs and/or a 36-page price list.

Circle letter (AM) on reply card.

(AN) PIPE LINE STRAINERS

A new 4-page bulletin just off the press describes the complete line of Anderson self-cleaning pipe line strainers made in sizes from ¼ to 3-in. An interesting discussion titled "Value of Sediment Control" points out the numerous pieces of pipe line equipment needing strainer protection. These include steam traps, reducing valves, air tools, pumps, temperature regulators, etc. V. D. Anderson Company.

Circle letter (AN) on reply card.

(AO) POWER WHEELBARROW

Low cost material handling with Moto-Bugs is pictorially shown in a new 4-page bulletin issued by the Kwik-Mix

Company. This equipment was introduced about 4 years ago. The new catalog contains 25 action photographs that demonstrate Moto-Bug operation in construction, industry, and maintenance work with the 10 cu ft hopper body; with the 1500 lb platform body, and with the 1000-lb hydraulic fork lift attachment.

Circle letter (AO) on reply card.

(AP) STEAM GENERATOR

A new 28-page bulletin No. 2000 especially prepared for describing the design features of the preferred unit steam generator, has been announced by Preferred Utilities Manufacturing Corporation. Combination gas and oil-fired unit is also described. Preferred units can be fired by light oil, heavy oil, natural and manufactured gas.

Circle letter (AP) on reply card.

(AQ) DRILL RIG

Joy Manufacturing Company announces a new bulletin on the 300 series of Joy motorized drill rigs. Two models, for slim-hole production and deep core testing, are described in 8 pages of photographs and specifications. Both are heavy-duty, truck or trailer-mounted portable rigs. Model 350 has capacities to 5000 ft and Model 300 drills to 4000 ft.

Circle letter (AQ) on reply card.

(AR) CYLINDER-FINISH TUBING

A new bulletin on Rockrite cylinder-finish tubing with greatly improved tolerances for hydraulic and pneumatic cylinders that permit standardization and savings in total cost of finished mechanism, has been announced by Tube Reducing Corporation. The bulletin shows how the Rockrite process in addition to producing closer bore tolerances also tends to iron out pits, scratches, or other irregularities.

Circle letter (AR) on reply card.

(AS) WELDING

Now available is a 12-page reprint of a talk, "Welding Iron-Bearing Alpha Aluminum Bronze," presented by F. E. Garriott, manager of the weldrod and wire department, Ampco Metal, Inc., at the annual meeting of the American Welding Society. Profusely illustrated, this booklet discusses test results of the weldability characteristics of aluminum bronze sheet and plate. Charts, graphs, and photographs help describe welding techniques and processes such as carbon-arc, inert gas metal-arc, metal-arc, inert gas consumable electrode, etc.

Circle letter (AS) on reply card.

(AT) CHLORINE COMPOUNDS

A new booklet that covers the family of "Organic Chlorine Compounds," has just been published by Carbide and Carbon Chemicals Company, a division of Union Carbide and Carbon Corporation. This booklet describes the 11 organic chlorine compounds sold in commercial quantities by the company; their uses, physical properties, specifications, and shipping data. Also included is a bibliography listing important references in the chemical literature to the organic chlorine compounds discussed.

Circle letter (AT) on reply card.

(AU) EMULSION TREATER

Black, Sivalls and Bryson, Inc., announces the publication of an 8-page bulletin on the new horizontal emulsion treater. Printed in two colors, the contents are arranged for easy reading, written in non-technical language, and fully illustrated with diagramatic drawings and charts. The BS&B horizontal emulsion treater is reportedly the only treater manufactured with a steam chest — a closed system requiring no make-up water and removable.

Circle letter (AU) on reply card.

(AV) OIL PURIFICATION

The Sharples Corporation crude oil purification system, which combines a continuous centrifugal oil purifier and a special fuel storage method, promises to free pipe line operators throughout the world from dependence on diesel fuel supplies. Heart of this oil purification system, described in an 8-page bulletin, is an automatic centrifuge that removes from the crude oil dirt, tank scale, and moisture, and produces a completely combustible, non-cratering fuel.

Circle letter (AV) on reply card.

(AW) AIR FILTERS

Continental Air Filters, Inc., has compiled a new technical data book on its automatic self-cleaning air filter, which, combined with its new Bulletin No. 201-D, constitutes complete information on a filter of this general type. Continental automatic self-cleaning air filters are suitable for a wide variety of air cleaning applications, including the protection of gas and diesel engines, air compressors, etc.

Circle letter (AW) on reply card.

Trade Literature

(AX) GENERAL CATALOG

Link-Belt Speeder Corporation has issued a general line catalog that provides a handy digest of all its current models. The catalog, Book No. 2373, includes photographs and brief descriptions and applications of 16 models of Link-Belt Speeder equipment. It also lists "master books," which contain complete data on each model to augment the thumbnail description contained in this general line catalog.

Circle letter (AX) on reply card.

(AY) FLOATING ROOFS

Graver Tank and Manufacturing Company, Inc., has published a 10-page bulletin featuring its double-deck floating roof tanks. The double-deck floating roof is a new design for the vapor-saving storage of gasolines and the corrosion-resistant storage of crudes. The roof, floating directly upon the surface of the liquid stored, eliminates any space for vapors to form or for corrosion to take place.

Circle letter (AY) on reply card.

(AZ) PANEL BOARDS

A profusely illustrated spiral-bound bulletin describing conventional and graphic type panel boards, as well as the measuring and control instruments utilized, has been published by Minneapolis-Honeywell Regulator Company. Bulletin 85-20 contains 32 pages with numerous pictures and diagrams. Some of the subjects covered include: System versatility, pneumatic and electric transmission, pneumatic receivers, pneumatic and electric controllers, etc.

Circle letter (AZ) on reply card.

(BA) VAPOR CONDENSERS

The Doyle and Roth Manufacturing Company is pleased to announce its new line of standard "stainless steel vapor condensers." These units are offered in two basic designs, Model VT for condensing vapors through the tube side, and Model VS for condensing vapors on the shell side. Through standardization and the stocking of the component parts, these units are available for quick delivery at low unit cost in type 316 stainless.

Circle letter (BA) on reply card.

(BB) CORROSION PREVENTION

The Petrolite Corporation, Ltd., has published a comprehensive bulletin on the usage of Kontol as a corrosion preventive in refineries and gasoline plants. Kontol corrosion preventives are organic chemical inhibitors designed to prevent corrosion encountered in hydrocarbon distillation systems and to protect against attack by chlorides, sulfides, or other agents. Kontol forms an adsorbed film over the metal surface, affording protection against its corrosive environment. The booklet shows diagrams and explains where to apply Kontol, including various methods of surveying corrosion rate.

Circle letter (BB) on reply card.

(BC) PIPE LOCATOR

Fisher Research Laboratory, Inc., has put out a new 2-color bulletin titled, "What Every Pipe Line Operator Should Know About Electronic Pipe-Locating

and Leak-Detecting." It describes the T-10 M-Scope, a box locator, which the company claims will locate exact position of buried pipe lines or metallic conductors, pipe bends, dead ends, valves, and other buried metals. It is said that the new locator determines the difference between a buried pipe and a single metal object.

Circle letter (BC) on reply card.

(BD) RATCHET WRENCH

Tubing Appliance Company has published an 8-page bulletin of a new tool, trade-named Tac, which is a ratchet, socket, and open-end wrench in one. Full-arc hinge handle allows complex wrenching jobs to be reached and worked. From the top, bottom, side or any angle, the Tac open-end ratchet wrench will fit and will ratchet fittings on or off.

Circle letter (BD) on reply card.

(BE) PLASTIC TAPES

Protecting buried pipes from corrosion with "Scotch" plastic tapes No. 21 and No. 22 is the subject of a new 8-page illustrated booklet published by Minnesota Mining and Manufacturing Company. It describes and illustrates both high speed machine and hand wrapping techniques for protecting natural gas and water mains, joints and leads from the corrosive effect of soil chemicals, etc.

The booklet cites some of the problems resulting from pipe corrosion as well as actual case histories of instances where the wrapping methods were.

Circle letter (BE) on reply card.

(BF) LOW ALLOY STEEL

The International Nickel Company, Inc., has published a 38-page booklet reprinting a talk by H. R. Copson, research chemist for the company, before the American Society for Testing Materials. Title of the talk is "A Theory of the Mechanism of Rusting of Low Alloy Steels in the Atmosphere." It contains many figures, pictures, and diagrams. The last 9 pages are devoted to a discussion on rusting of low alloy steel by H. E. Smith, materials engineer.

Circle letter (BF) on reply card.

(BG) DEAERATING HEATERS

A new bulletin on tray-type deaerating heaters has just been printed by Graver Water Conditioning Company, manufacturers of equipment for all water treating processes. An introductory section of the bulletin explains the principles of successful deaeration and the essential elements of a deaerating heater. The features of Graver Tray-Type and Spray-Tray-Type heaters are described in tabular form, and illustrated by detailed drawings with identification of all parts. Included in the bulletins are also flow diagrams and photographs of typical Graver Heater installations.

Circle letter (BG) on reply card.

(BH) SMOKELESS FUEL

Stilcok Company has published a 16-page bulletin describing Stilcok, which is described as being smokeless fuel, or coke made in "stils" of all welded steel construction. The heating surface, or "oven is inside the material," or coal charged into the stil. The material thus surrounds the oven, or radiator. A charge of coal 4 in. in thickness over the entire area of the radiator is distilled, or coked in about 3 hr. or at the rate of 1.33 in. per hour.

Circle letter (BH) on reply card.

(BI) COOLING FANS

Koppers Company, Inc., has published a 4-page brochure on its industrial cooling fans. In the manufacture the Aeromaster fan is prebalanced in a draft-free room. After it is balanced, each blade and its matching socket are keyed with a number. Then the blades are removed and the fan crated for shipping. On location, the fans can be reassembled by un-killed labor without troubles.

Circle letter (BI) on reply card.

(BJ) OVERLOAD RELEASE

Dodge Manufacturing Corporation has announced a new, compact 4-page bulletin, A-616, giving full information about the new Tri-Matic overload release recently announced for its line of torque-arm speed reducers. All engineering data, required for the overload release and list prices are shown in drawings and table.

Circle letter (BJ) on reply card.

(BK) FORK LIFT TRUCKS

The Buda Company has published three new bulletins illustrating and describing models of its new "FT Series" fork lift trucks. Bulletin No. 1579 describes Models FT30-24, gasoline powered and model FTD30-24 diesel powered fork lift trucks, with 3000-lb capacity at a 24-in. load center. Bulletin 1580 illustrates the FT40-18, gasoline, and FTD40-18, diesel, fork lift trucks, with 4000-lb capacity at an 18-in. load center. Bulletin No. 1481 concerns the FT40-24, gasoline and FT40-24, diesel, fork lift truck, with 4000-lb capacity at 24-in. load center.

Circle letter (BK) on reply card.

(BL) MICROWAVE

A new brochure entitled "What Is Microwave," latest in a series of RCA Victor pamphlets for industry, describes the latest developments and potentialities in radio equipment for point-to-point communication or remote control. The 20-page illustrated booklet, just published by RCA, explains how any factor that can be translated into an electrical impulse can be transmitted by means of microwave equipment from various points to a central location.

Circle letter (BL) on reply card.

(BM) SWITCHGEAR EQUIPMENT

A new 12-page catalog has just been released by Electric Service Engineering Company. The new catalog illustrates the range of switchgear equipment, known by the trade name "Eseco." There is shown a wide variety of control equipment designed by the company in low voltage and medium voltage capacities. In addition, other special types of controls that have been manufactured for special use are illustrated.

Circle letter (BM) on reply card.

(BN) DITCHERS

Two new catalogs describing the Buckeye Model 314 and Model 303 wheel type ditchers have been announced by Gar Wood Industries, Inc., manufacturers of Buckeye ditchers. The Model 314 catalog explains in detail the construction and operational features of this pipe line and utility ditcher, which features with a fluid coupling more efficient power transmission and longer service life through cushioning of shock. The 303, features ease of accurate operation and efficient power transmission.

Circle letter (BN) on reply card.

(BO) VALVE DATA

A 24-page bulletin, with pasteboard covers gives general data on designs, facilities, materials, etc., used in valves manufactured by the Brown Valve Company, division of Vernon Tool Company, Ltd. In the front is a swing check valves condensed data sheet containing pipe size inches, type end, list prices, face to face inches, and approximate weight. The various types of valves are featured with diagrams, prices, and dimensions, and test pressure and temperature ratings.

Circle letter (BO) on reply card.

(BP) COUPLINGS AND NIPPLES

A condensed version of its large general catalog has just been issued by the Wheeling Machine Products Company. The 4-page digest edition is the standard 8½ by 11-in. page size, and is punched for easy insertion into a salesman's standard portfolio. Advantages claimed for the condensation are: More convenient for the jobbers' salesmen to carry; it is a handy and quick reference for information on pipe couplings and nipples; and others.

Circle letter (BP) on reply card.

(BQ) CRAWLER CRANE

A catalog describing the new American crawler crane has been made available for distribution by American Hoist and Derrick Company. The new catalog shows action views of the new crane. It points up the availability of interchangeable fronts—crane, shovel, dragline, or pull shovel and lists overall specifications.

Circle letter (BQ) on reply card.

(BR) WORM GEAR

Just off the press is the Cleveland Worm and Gear Company's new general Catalog No. 400. Its 180 pages illustrate and describe each model in the complete line of Cleveland worm gear speed reducers as well as worm and gear sets for built-in power transmission applications. It contains engineering and application data on each unit, including dimensions, weights, and rating tables, and other information.

Circle letter (BR) on reply card.

(BS) PIPE FITTINGS

Tennessee Eastman Company announces the publication of a new book, *Fittings for Pipe Extruded of Tenite*. With aid of detailed diagrams, the book describes the fabrication of various fittings from extruded pipe lengths and the methods of installing these joints in pipe lines.

Circle letter (BS) on reply card.

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STURDYBILT
PREFABRICATED HOUSES

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Get STURDYBILT Prefabricated Houses . . . Houses that are designed for the oil industry.

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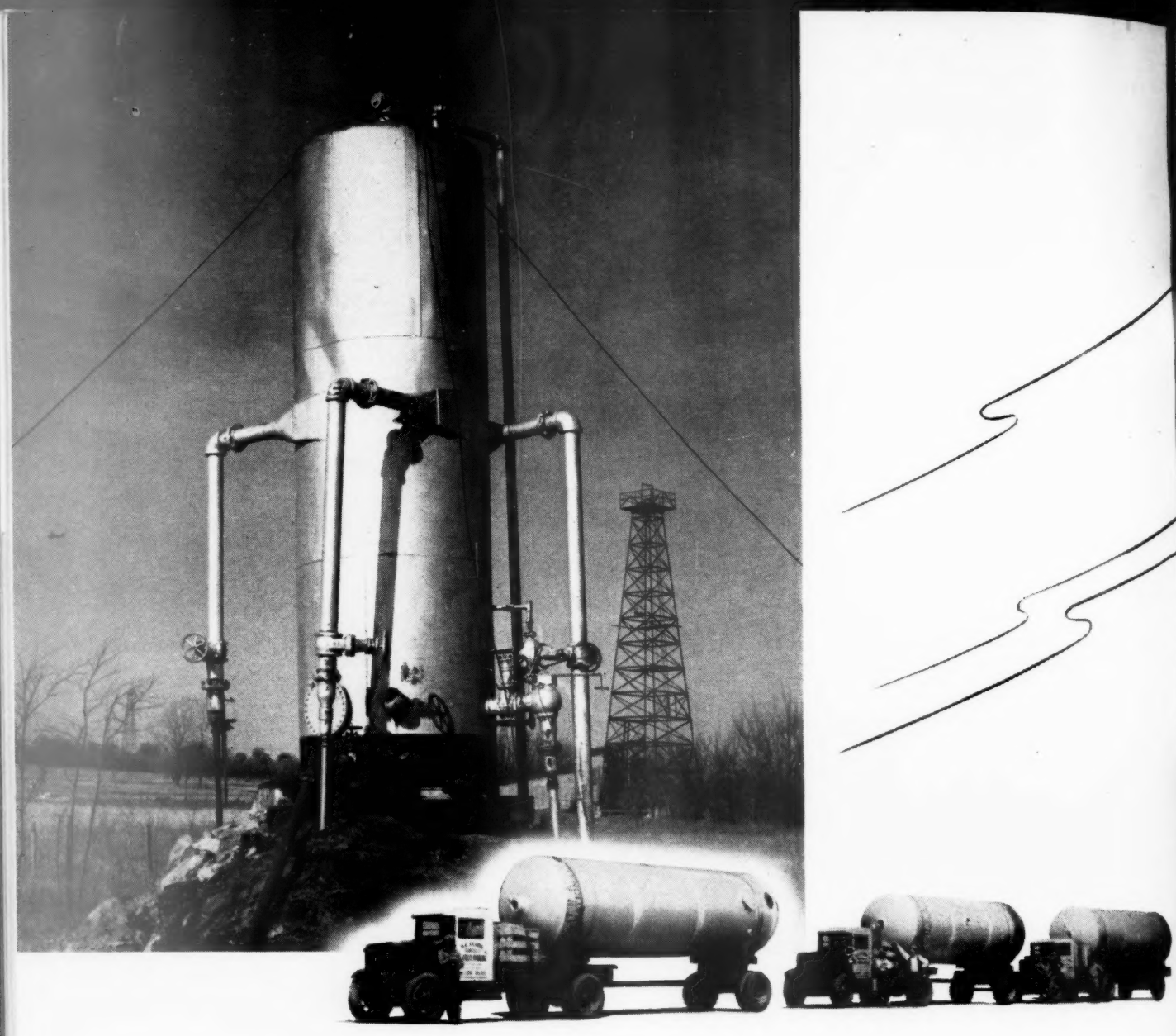
STURDYBILT HOUSES COMPLY WITH COMMERCIAL STANDARD CS120 OF THE NATIONAL BUREAU OF STANDARDS FOR PREFABRICATED HOMES



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CONTINUOUS SERVICE

On September 15, 1927, one of the first Separators manufactured by National Tank Company was set on a lease in Seminole County, Oklahoma. Initial production was 250 barrels per hour from a 4284 foot well. Over the years, production has gradually declined. Production is now much less per day, but this is the story of one National Separator — still serving after 25 years' continuous operation. Comparable results are experienced by operators throughout the oil producing world. Make your next Separator a National.

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GASO World's Best Known Portable Pumps

The fame of the blue whale rests on the fact that it is the largest of all creatures alive or extinct—100 feet long and weighing 150 tons.

The fame of GASO PUMPS lies in the fact that they do a whale-size job with minimum size and weight. Completely dependable, unbelievably durable, they have for more than a third of a century supplied everything that the pipeline engineer wants in flexible, portable and salvable pumping units.

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for better pipe protection

1 The Barrett Field Manual

2 On-the-Job Technical Aid

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Resistance to extreme atmospheric temperatures
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High resistance to soil stresses
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Moisture impermeability
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On-the-job technical assistance
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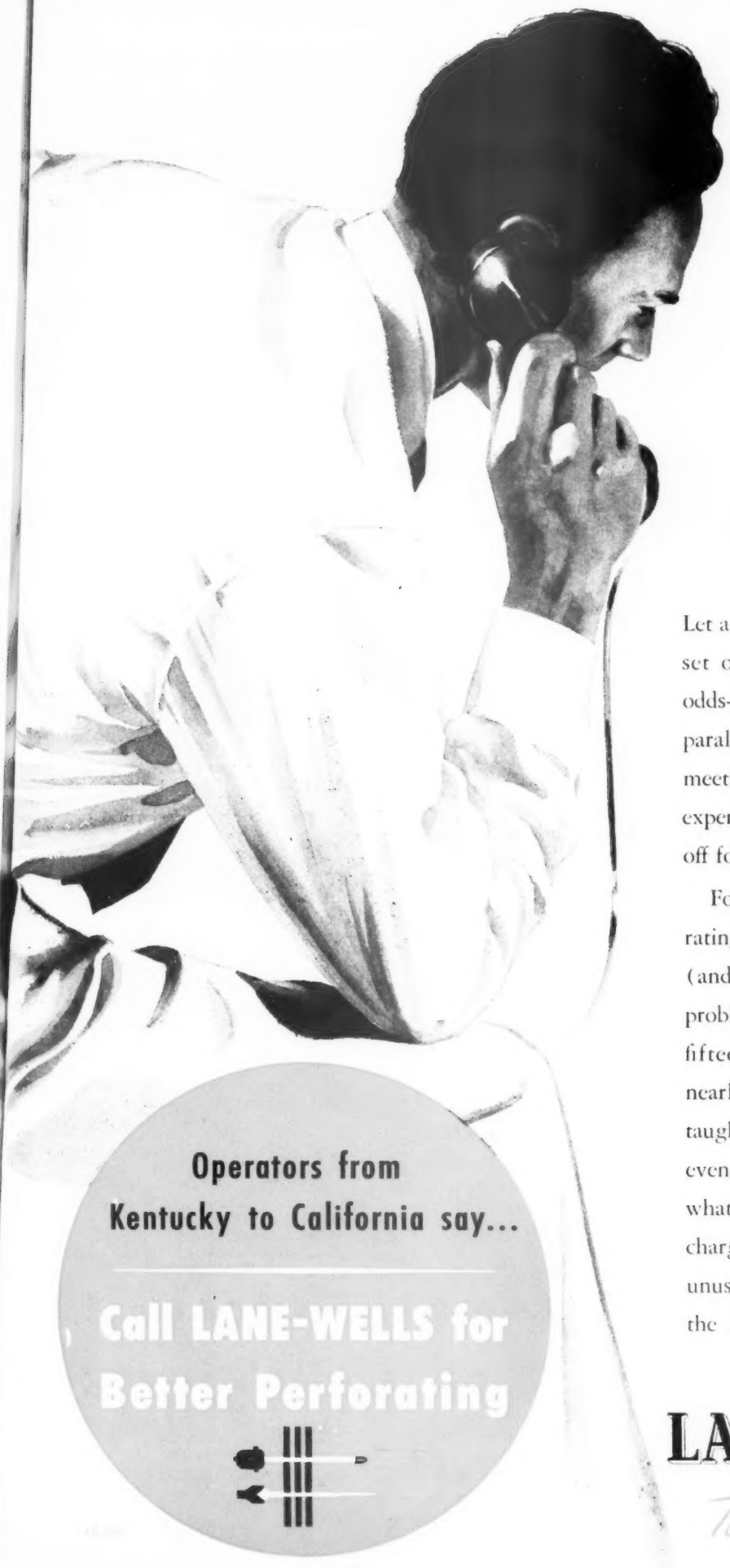
To obtain more information on products advertised see page E-51



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"...Those same well conditions occurred over in Kansas in 1943... Here's how they were handled"

Let a difficult problem arise, or an unusual set of conditions crop up, and it's an odds-on bet your Lane-Wells man can cite a parallel case and outline the best way of meeting the present situation. That's how experience—Lane-Wells experience—pays off for you.

For, in doing more than 170,000 perforating jobs, your Lane-Wells men have met (and helped to answer) practically every problem an oil well can offer. Five, ten, fifteen or more years of experience in nearly every oil field in this country have taught Lane-Wells men how to handle even the most difficult perforating jobs—what guns to use, whether bullet, shape-charge or combination, what set-up, what unusual precautions to take. And they have the finest equipment to do those jobs!

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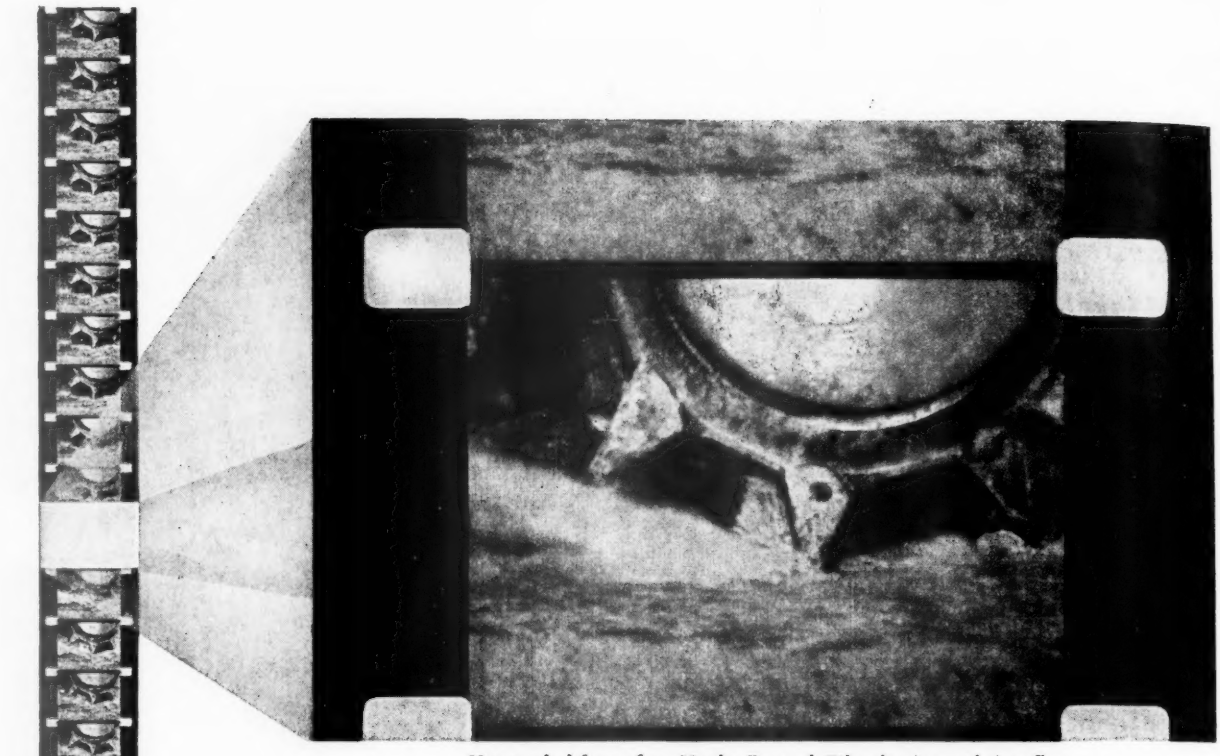

Unretouched frame from Hughes Research Film showing explosive effect as heel tooth penetrates formation.

Hughes advances tooth action research

Knowing exactly what happens when bit teeth bite into the formation is essential in perfecting bit design.

Every means that will clarify tooth action is used by Hughes engineers. This includes the study of bottom hole patterns, data obtained from millions of bits run on thousands of rigs, and motion pictures taken with super high speed camera equipment.

This is work in which small improvements are important. For instance, a design change that leads to the removal of 1/64" more formation on each revolution of the bit can increase the penetration rate approximately five feet per hour at a rotary speed of 60 to 70 RPM.

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